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Billie H. Hix

BILLIE H. HIX
Chief, Technical Systems Branch
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# VHB STATISTICAL MANUAL

Primary purpose of this manual is to present information pertaining to the Twentieth Air Force and the B-29 Superfortress aircraft. The factors compiled here depend upon various variables which will be continually changing the contents. Revisions and improvements to the manual will be published monthly by the Headquarters, Twentieth Air Force. Copies of the revisions will be forwarded to the various organizations that are on the distribution list.

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## Organization

### Headquarters, Twentieth Air Force

1. CONSTITUTION. The Twentieth Air Force was constituted 4 April 1944, (WD Letter AG 322, 4 April 1944) with station in Washington, D. C. The Headquarters, Twentieth Air Force was activated by General Orders No. 2, Headquarters, Army Air Forces, 4 April 1944. The War Department authority constituting the Twentieth Air Force stipulated that it would be commanded by the Commanding General, Army Air Forces. This War Department directive also specified that the Headquarters, Army Air Forces, functioning in a dual capacity, would perform the necessary staff functions of the Headquarters, Twentieth Air Force. No Table of Organization is provided for the Headquarters, Twentieth Air Force.

2. STAFF. The Staff of the Headquarters, Twentieth Air Force is announced in General Orders No. 12, Headquarters, Twentieth Air Force, 2 December 1944. With the exception of the Deputy Commander, all of the members of the staff of the Headquarters, Twentieth Air Force are assigned to the Headquarters, Army Air Forces, and most of them are occupying dual staff positions in the Headquarters Army Air Forces. Each staff officer occupying a dual position will designate at least one operating assistant who will devote his attention primarily to Twentieth Air Force matters. These operating assistants are the individuals through whom the normal business of the Twentieth Air Force will be transacted with the various staff divisions of the Headquarters, Army Air Forces. These operating assistants will be responsible for the coordination of Twentieth Air Force matters within their own staff divisions and with the operating assistants of other staff divisions.

3. DECENTRALIZATION OF ADMINISTRATIVE RESPONSIBILITIES. In so far as practicable, administrative responsibilities will be delegated to the Deputy Commanders of the Twentieth Air Force and to the Commanding Generals of the Bomber Commands, who will have administrative authority and responsibilities comparable to that of an Air Force Commander.

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## ORGANIZATION OF THE TWENTIETH AIR FORCE

A total of 40 VHB Groups is scheduled to be deployed in the war against Japan. Two Bomber Commands and six Wings are at present activated.

**XXI Bomber Command**

The XXI Bomber Command is at present deployed in the Marianas with the Headquarters located at the Depot Field on Guam. The XXI Bomber Command is scheduled to be composed of five VHB Wings. The 73d Wing is now deployed on Isley #1 at Saipan, the 313th at North Tinian Field, and the 314th at North Field, Guam. The 58th Wing will operate from West Field, Tinian. The 315th Wing at present in training is the last of the five Wings to arrive in the Marianas. This Wing will be deployed on Northwest Field, Guam. Two Groups have a readiness date of 20 May and two Groups 20 June 1945.

**XX Bomber Command**

The XX Bomber Command Headquarters, 22nd Depot Group, and supporting units will move from India June 6th arriving in Okinawa August 4th, August 24th and September 3d respectively, for permanent deployment in Okinawa. Current plans provide for the XX Bomber Command to be composed of five Wings.

The 316th Wing now fully organized and at present in training will be deployed on Kadena Field, Okinawa, as follows: two Groups 15 August and two Groups 15 September 1945.

"A" Wing will consist of the 489th Bomb Group to be deployed on Bolo Field, 1 September 1945. Three converted Groups will complete the organization of "A" Wing, one Group being deployed Bolo Field 1 October 1945, and two Groups deployed Bolo 1 November 1945.

"B" Wing will consist of four converted Groups, two Groups scheduled for deployment on Futema on 1 December 1945, and two Groups Kadena 1 January 1945.

The location of the remaining two Wings is at present undetermined. These two Wings will be composed of converted Groups, four scheduled for deployment 1 February 1946, and four Groups 1 March 1946.

**Wing**

The VHB Wing consists of four Groups, and the Group is made up of three Squadrons. A VHB Wing is allotted a total of 180 B-29 aircraft. 120 of these are unit equipment and 60 are reserve.

11 May 1945

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ESTIMATED AVAILABILITY OF VLR GROUPS FOR DEPLOYMENT

| Month | Augmented Program B-29 | Conversion Program B-29 |
|---|---|---|
| Nov 1944 | 4 | (see conversion section of this Manual) |
| Dec 1944 | | |
| Jan 1945 | 4 | |
| Feb 1945 | 2 | |
| Mar 1945 | 2 | |
| Apr 1945 | see note below | |
| May 1945 | 2 | |
| Jun 1945 | 2 | |
| Jul 1945 | | |
| Aug 1945 | 2 | |
| Sept 1945 | 2 | 1 |
| Oct 1945 | | 1 |
| Nov 1945 | | 2 |
| Dec 1945 | | 2 |
| Jan 1946 | | 2 |
| Feb 1946 | | 4 |
| Mar 1946 | | 4 |

NOTE: Four B-29 Groups and C Flight of 1st Recon Squadron now in CBI will move to the Marianas -- April 20 to May 10.

15 May 45

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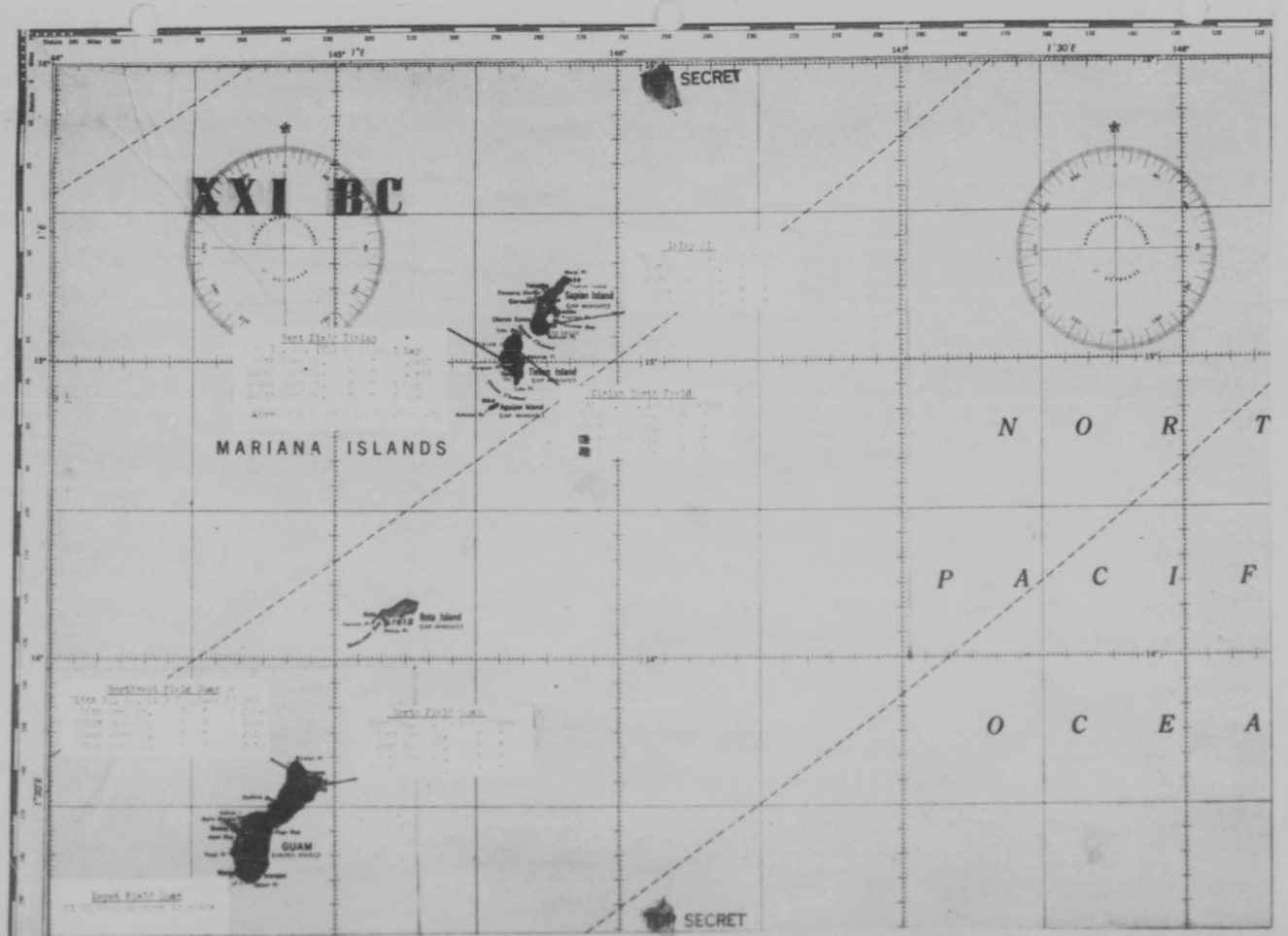


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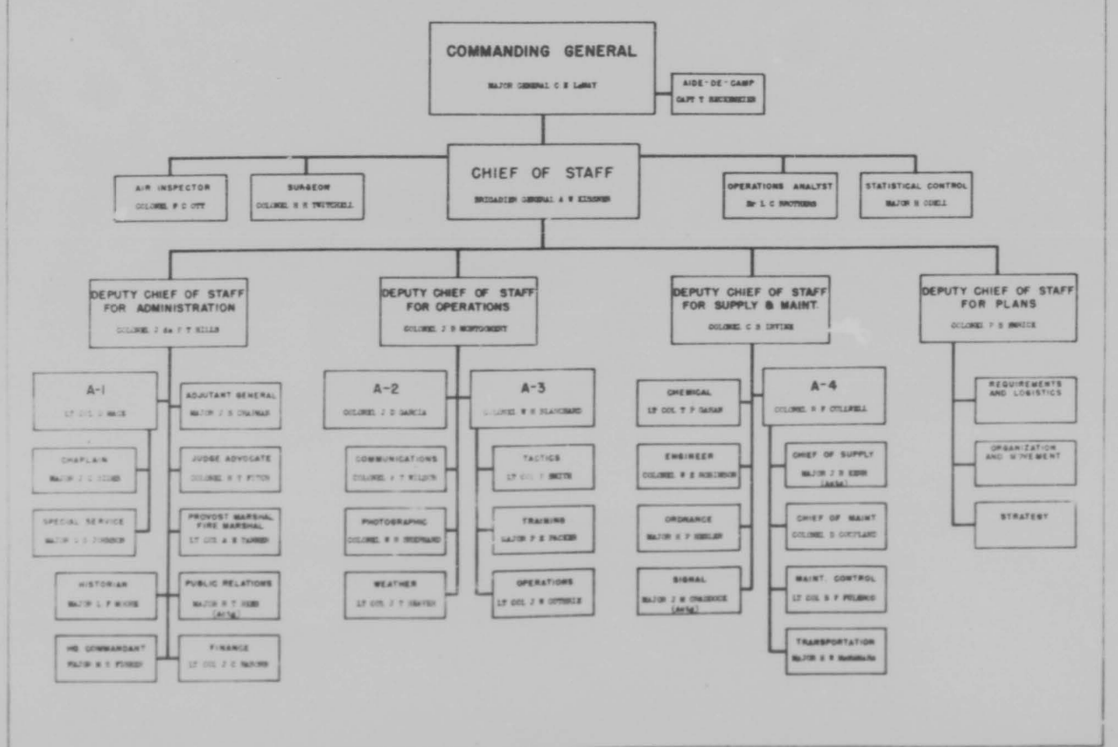
# HEADQUARTERS XXI BOMBER COMMAND
## STAFF ORGANIZATION CHART

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XXI ~~BOMBER~~ COMMAND

## ORGANIZATIONS AT GUAM

| ORGANIZATION | SUB - UNIT | AUTHORIZED STRENGTH | | | STRENGTH IN THEATER | | | ESTIMATED ARRIVAL DATE OF UNITS NOT YET IN THEATER | |
|---|---|---|---|---|---|---|---|---|---|
| | | OFF | E.M. | TOTAL | OFF | E.M. | TOTAL | GROUND ECH | AIR & FLIGHT |
| COMMAND HEADQUARTERS | | | | | | | | | |
| Hq XXI Bomber Command | | 197 | 427 | 624 | 259 | 466 | 725 | | |
| 4th Oper Analysis Section | | 6 | 10 | 16 | | 10 | 10 | | |
| 5th Veterinary Det | | 1 | 3 | 4 | 1 | 3 | 4 | | |
| 11th Combat Camera Unit | | 9 | 23 | 32 | 5 | 24 | 33 | | |
| 17th Radio Security Section* | | 2 | 36 | 38 | 2 | 35 | 37 | | |
| 18th Radio Security Section* | | 2 | 36 | 38 | 1 | 36 | 37 | | |
| 18th Historical Unit | | 2 | 2 | 4 | 2 | 2 | 4 | | |
| 33rd Statistical Control Unit | | 13 | 80 | 93 | 12 | 80 | 92 | | |
| 35th Photo Technical Unit | | 36 | 89 | 125 | 36 | 89 | 125 | | |
| 234th Army Postal Unit* | | 1 | 11 | 12 | 1 | 11 | 12 | | |
| 279th Medical Dispensary, Avn | | 4 | 23 | 27 | 4 | 23 | 27 | | |
| 383rd Signal Co, Avn | | 12 | 193 | 205 | 12 | 192 | 204 | | |
| 384th Signal Co, Avn | | 12 | 193 | 205 | 12 | 192 | 204 | | |
| 4404th Signal Construction Bn* | | 15 | 229 | 244 | 9 | 107 | 116 | | |
| 827th Chemical Co, Air Oper | | 4 | 130 | 134 | | | | 15 Jun 45 | |
| 840th Chemical Co, Air Oper | | 4 | 130 | 134 | | | | 28 May 45 | |
| 949th Engineer Depo Co | | 10 | 150 | 160 | 9 | 151 | 160 | | |
| 1600th Quartermaster Car Co | | 5 | 124 | 129 | 3 | 124 | 127 | | |
| TOTAL | | 335 | 1990 | 2325 | 367 | 1467 | 1834 | | |
| Hq 314th Bombardment Wing | | 88 | 136 | 224 | 97 | 116 | 213 | | |
| 329th Signal Co, Wing | | 8 | 119 | 127 | 8 | 117 | 125 | | |
| 595th AAF Band | | 1 | 28 | 29 | 1 | 28 | 29 | | |
| 802nd Chemical Co, Air Oper | | 4 | 130 | 134 | 4 | 128 | 132 | | |
| 19th Bomb Group | Hq, 2f, 30, 93 Sqs | 402 | 1676 | 2078 | 414 | 1668 | 2082 | | |
| | 24th Photo Lab Sp | | | | | | | | |
| 29th Bomb Group | Hq, 6, 43, 52 Sqs | 402 | 1676 | 2078 | 433 | 1676 | 2119 | | |
| | 25th Photo Lab Sp | | | | | | | | |
| 39th Bomb Group | Hq, 60, 61, 62 Sqs | 402 | 1676 | 2078 | 345 | 1584 | 1929 | | |
| | 27th Photo Lab Sp | | | | | | | | |
| 330th Bomb Group | Hq, 457, 458, 459 Sqs | 402 | 1676 | 2078 | 330 | 1509 | 1839 | | |
| | 26th Photo Lab Sp | | | | | | | | |
| 31st Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 28 | 284 | 312 | | |
| | 57th Air Materiel Sq | 8 | 134 | 142 | 8 | 132 | 140 | | |
| | 56th Air Engr Sq | 12 | 246 | 258 | 11 | 245 | 256 | | |
| 69th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 279 | 305 | | |
| | 575th Air Materiel Sq | 8 | 134 | 142 | 8 | 131 | 139 | | |
| | 305th Air Engr Sq | 12 | 246 | 258 | 12 | 244 | 256 | | |
| 89th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 281 | 307 | | |
| | 501st Air Materiel Sq | 8 | 134 | 142 | 8 | 132 | 140 | | |
| | 502nd Air Engr Sq | 12 | 246 | 258 | 12 | 243 | 255 | | |
| 90th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 27 | 278 | 305 | | |
| | 507th Air Materiel Sq | 8 | 134 | 142 | 8 | 128 | 136 | | |
| | 508th Air Engr Sq | 12 | 246 | 258 | 12 | 246 | 258 | | |
| TOTAL | | 1901 | 9793 | 11694 | 1823 | 9495 | 11318 | | |
| Hq 315th Bombardment Wing | | 88 | 136 | 224 | 48 | 104 | 152 | | 1 Jun 45 |
| 339th Signal Co, Wing | | 8 | 119 | 127 | | | | 17 May 45 | |
| 16th Bomb Group | Hq, 15, 16, 17 Sqs | 402 | 1676 | 2078 | 36 | 684 | 720 | | 1 Jun 45 |
| | 23rd Photo Lab Sp | | | | | | | | |
| 331st Bomb Group | Hq, 355, 356, 357 Sqs | 402 | 1676 | 2078 | | | | 15 May 45 | 10 Jun 45 |
| | 30th Photo Lab Sp | | | | | | | | |
| 501st Bomb Group | Hq, 21, 41, 485 Sqs | 402 | 1676 | 2078 | 37 | 693 | 730 | | 1 Jun 45 |
| | 28th Photo Lab Sp | | | | | | | | |
| 502nd Bomb Group | Hq, 402, 411, 430 Sqs | 402 | 1676 | 2078 | | | | 15 May 45 | 10 Jun 45 |
| | 29th Photo Lab Sp | | | | | | | | |
| 24th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | | | | 15 May 45 | |
| | 552nd Air Materiel Sq | 8 | 134 | 142 | | | | 15 May 45 | |
| | 551st Air Engr Sq | 12 | 246 | 258 | | | | 15 May 45 | |
| 73rd Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 290 | 316 | | |
| | 580th Air Materiel Sq | 8 | 134 | 142 | 8 | 134 | 142 | | |
| | 586th Air Engr Sq | 12 | 246 | 258 | 11 | 237 | 248 | | |
| 75th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | | | | 15 May 45 | |
| | 581st Air Materiel Sq | 8 | 134 | 142 | | | | 15 May 45 | |
| | 587th Air Engr Sq | 12 | 246 | 258 | | | | 15 May 45 | |
| 76th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 28 | 293 | 321 | | |
| | 582nd Air Materiel Sq | 8 | 134 | 142 | 8 | 136 | 144 | | |
| | 588th Air Engr Sq | 12 | 246 | 258 | 11 | 245 | 256 | | |
| TOTAL | | 1896 | 9635 | 13531 | 215 | 2714 | 3029 | | |
| DEPOT FIELD | | | | | | | | | |
| 3rd Photo Recon Sq, VIP* | | 160 | 576 | 736 | 209 | 600 | 809 | | |
| 655th Bomb Sq (H) Weather Recon* | Flight "A" | 19 | 94 | 113 | 19 | 94 | 113 | | |
| | Flight "B" | 28 | 166 | 194 | 12 | 165 | 177 | | 15 May 45 |
| | Flight "C" | 19 | 94 | 113 | | | | 1 Jun 45 | — May 45 |
| TOTAL | | 226 | 930 | 1156 | 240 | 859 | 1099 | | |
| ISLAND TOTAL | | 4350 | 22249 | 26606 | 2945 | 14699 | 17734 | | |

* Attached Units

17 April 1945



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XXI BOMBER COMMAND

## ORGANIZATIONS AT TINIAN

| ORGANIZATION | SUB - UNIT | AUTHORIZED STRENGTH | | | STRENGTH IN THEATER | | | ESTIMATED ARRIVAL DATE OF UNITS NOT YET IN THEATER | |
|---|---|---|---|---|---|---|---|---|---|
| | | OFF | E.M. | TOTAL | OFF | E.M. | TOTAL | GROUND | AIR & FLIGHT |
| Hq 313th Bombardment Wing | | 88 | 136 | 224 | 105 | 142 | 247 | | |
| 325th Signal Co, Wing | | 8 | 119 | 127 | 8 | 117 | 125 | | |
| 492nd AAF Band | | 1 | 28 | 29 | 1 | 28 | 29 | | |
| 813th Chemical Co, Air Oper | | 4 | 130 | 134 | 4 | 124 | 128 | | |
| 881st Chemical Co, Air Oper | | 4 | 130 | 134 | 4 | 131 | 135 | | |
| 6th Bomb Group | Hq, 24, 39, 40 Sqs | 402 | 1676 | 2078 | 376 | 1709 | 2085 | | |
| | 22nd Photo Lab Gp | | | | | | | | |
| 9th Bomb Group | Hq, 1, 5, 99 Sqs | 402 | 1676 | 2078 | 383 | 1724 | 2107 | | |
| | 19th Photo Lab Gp | | | | | | | | |
| 50th Bomb Group | Hq, 395, 421 Sqs | 402 | 1676 | 2078 | 266 | 1165 | 1431 | | |
| | 6Oth Sq | | | | | | | 10 Jun 45 | ** |
| | 20th Photo Lab Gp | | | | | | | | |
| 505th Bomb Group | Hq, 482, 483, 484 Sqs | 402 | 1676 | 2078 | 354 | 1700 | 2054 | | |
| | 21st Photo Lab Gp | | | | | | | | |
| 72nd Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 28 | 285 | 313 | | |
| | 579th Air Materiel Sq | 8 | 134 | 142 | 8 | 133 | 141 | | |
| | 535th Air Engr Sq | 12 | 246 | 258 | 12 | 248 | 260 | | |
| 77th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 285 | 311 | | |
| | 576th Air Materiel Sq | 8 | 134 | 142 | 8 | 135 | 143 | | |
| | 534th Air Engr Sq | 12 | 246 | 258 | 12 | 246 | 258 | | |
| 358th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 27 | 281 | 308 | | |
| | 567th Air Materiel Sq | 8 | 134 | 142 | 7 | 132 | 139 | | |
| | 568th Air Engr Sq | 12 | 246 | 258 | 12 | 245 | 257 | | |
| 359th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 27 | 288 | 315 | | |
| | 569th Air Materiel Sq | 8 | 134 | 142 | 8 | 134 | 142 | | |
| | 570th Air Engr Sq | 12 | 246 | 258 | 12 | 246 | 258 | | |
| TOTAL | | 1905 | 9923 | 11828 | 1688 | 9498 | 11186 | | |
| 509th Composite Group* | Hq and Hq Squadron | 28 | 66 | 94 | | | | 28 May 45 | 5 Jul 45 |
| | 393rd Bomb Sq | 94 | 430 | 524 | | | | 28 May 45 | 5 Jul 45 |
| | 320th Troop Carrier Sq | 36 | 116 | 152 | | | | 28 May 45 | 5 Jul 45 |
| | 390th Air Service Group | | | | | | | | |
| | Hq and Base Serv Sq | 22 | 171 | 193 | | | | 28 May 45 | 5 Jul 45 |
| | 1027th Air Materiel Sq | 13 | 132 | 145 | | | | 28 May 45 | 5 Jul 45 |
| | 603rd Air Engr Sq | 14 | 271 | 285 | | | | 28 May 45 | 5 Jul 45 |
| | 1st Ordnance Sq, Avn (Sp) | 26 | 276 | 302 | | | | 10 Jul 45 | |
| | 1395th W. P. Co, Avn | 4 | 128 | 132 | | | | 28 May 45 | 5 Jul 45 |
| TOTAL | | 237 | 1590 | 1827 | | | | | |
| Hq 58th Bombardment Wing | | 88 | 136 | 224 | 67 | 128 | 195 | | 7 May 45 |
| 338th Signal Co, Wing | | 8 | 119 | 127 | 8 | 119 | 127 | | |
| 1903rd Ordnance Amm Co | | 6 | 173 | 179 | | | | 13 Jun 45 | |
| 40th Bomb Group | Hq, 25, 44, 45 Sqs | 402 | 1676 | 2078 | 43 | 1231 | 1274 | | 27 Apr 45 |
| | 11th Photo Lab Gp | | | | | | | | |
| 444th Bomb Group | Hq, 676, 677, 678 Sqs | 402 | 1676 | 2078 | 26 | 561 | 587 | 13 Jun 45 | 7 May 45 |
| | 12th Photo Lab Gp | | | | | | | | |
| 462nd Bomb Group | Hq, 768, 769, 770 Sqs | 402 | 1676 | 2078 | 43 | 1225 | 1268 | | 27 Apr 45 |
| | 13th Photo Lab Gp | | | | | | | | |
| 468th Bomb Group | Hq, 792, 793, 794 Sqs | 402 | 1676 | 2078 | 21 | 580 | 601 | 13 Jun 45 | 7 May 45 |
| | 14th Photo Lab Gp | | | | | | | | |
| 25th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | | | | 13 Jun 45 | |
| | 578th Air Materiel Sq | 8 | 134 | 142 | 16 | 326 | 342*** | 13 Jun 45 | |
| | 35th Air Engr Sq | 12 | 246 | 258 | | | | 13 Jun 45 | |
| 28th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 12 | 138 | 150 | 13 Jun 45 | |
| | 58th Air Materiel Sq | 8 | 134 | 142 | 3 | 62 | 65 | 13 Jun 45 | |
| | 39th Air Engr Sq | 12 | 246 | 258 | 5 | 110 | 115 | 13 Jun 45 | |
| 86th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 19 | 271 | 290**** | 13 Jun 45 | |
| | 585th Air Materiel Sq | 8 | 134 | 142 | 3 | 63 | 66 | 13 Jun 45 | |
| | 349th Air Engr Sq | 12 | 246 | 258 | | | | 13 Jun 45 | |
| 77th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 10 | 170 | 180 | 13 Jun 45 | |
| | 579th Air Materiel Sq | 8 | 134 | 142 | 3 | 60 | 63 | 13 Jun 45 | |
| | 355th Air Engr Sq | 12 | 246 | 258 | 5 | 101 | 107 | 13 Jun 45 | |
| TOTAL | | 1902 | 9858 | 11760 | 285 | 5345 | 5630 | | |
| ISLAND TOTAL | | 4444 | 21321 | 25765 | 1973 | 14843 | 16816 | | |

* Attached Units.

** No flight echelon. Combat crew personnel to be drawn from crew in theater.

*** Includes personnel attached from Hq, 25th Air Service Gp and from 35th Air Engr Sq.

**** Includes personnel attached from 349th Air Engr Sq.

NOTE: Estimated arrival dates for 58th Wing are for last element of each echelon.

17 April 1945





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XXI BOMBER COMMAND

## ORGANIZATIONS AT SAIPAN

| ORGANIZATION | SUB-UNIT | AUTHORIZED STRENGTH | | | STRENGTH IN THEATER | | | ESTIMATED ARRIVAL DATE OF UNITS NOT YET IN THEATER | |
|---|---|---|---|---|---|---|---|---|---|
| | | OFF | E.M. | TOTAL | OFF | E.M. | TOTAL | GROUND | AIR & FLIGHT |
| Hq 73rd Bombardment Wing | | 88 | 136 | 224 | 97 | 148 | 245 | | |
| 323rd Signal Company, Wing | | 8 | 119 | 127 | 8 | 116 | 124 | | |
| 558th AAF Band | | 1 | 28 | 29 | 1 | 27 | 28 | | |
| 870th Chemical Company, Air Oper | | 4 | 130 | 134 | 4 | 128 | 132 | | |
| 887th Chemical Company, Air Oper | | 4 | 130 | 134 | 4 | 117 | 121 | | |
| 497th Bomb Group | Hq, 869, 870, 871 Sqs 15th Photo Lab Gp | 402 | 1676 | 2078 | 437 | 1760 | 2197 | | ALL |
| 498th Bomb Group | Hq, 873, 874, 875 Sqs 16th Photo Lab Gp | 402 | 1676 | 2078 | 444 | 1764 | 2208 | | UNITS |
| 499th Bomb Group | Hq, 877, 878, 879 Sqs 17th Photo Lab Gp | 402 | 1676 | 2078 | 443 | 1761 | 2204 | | NOW |
| 500th Bomb Group | Hq, 881, 882, 883 Sqs 18th Photo Lab Gp | 402 | 1676 | 2078 | 442 | 1739 | 2181 | | IN |
| 45th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 281 | 307 | | THEATER |
| | 573rd Air Materiel Sq | 8 | 134 | 142 | 9 | 136 | 145 | | |
| | 3rd Air Engr Sq | 12 | 246 | 258 | 11 | 246 | 257 | | |
| 91st Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 284 | 310 | | |
| | 572nd Air Materiel Sq | 8 | 134 | 142 | 8 | 129 | 137 | | |
| | 302nd Air Engr Sq | 12 | 246 | 258 | 11 | 247 | 258 | | |
| 305rd Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 27 | 284 | 311 | | |
| | 73rd Air Materiel Sq | 8 | 134 | 142 | 7 | 129 | 136 | | |
| | 327th Air Engr Sq | 12 | 246 | 258 | 13 | 242 | 255 | | |
| 330th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | 26 | 290 | 316 | | |
| | 301st Air Materiel Sq | 8 | 134 | 142 | 8 | 135 | 143 | | |
| | 52nd Air Engr Sq | 12 | 246 | 258 | 13 | 24. | 260 | | |
| TOTAL | | 1905 | 5923 | 11826 | 2065 | 10210 | 12275 | | |

XXI BOMBER COMMAND

## ORGANIZATIONS AT IWO JIMA

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 347th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | | | 2 May 45 |
| | 553rd Air Materiel Sq | 8 | 134 | 142 | | | 2 May 45 |
| | 309th Air Engr Sq | 12 | 246 | 258 | | | 2 May 45 |
| 348th Air Service Group | Hq and Base Serv Sq | 28 | 289 | 317 | | | 24 May 45 |
| | 554th Air Materiel Sq | 8 | 134 | 142 | | | 24 May 45 |
| | 550th Air Engr Sq | 12 | 246 | 258 | | | 24 May 45 |
| TOTAL | | 96 | 1338 | 1434 | | | |

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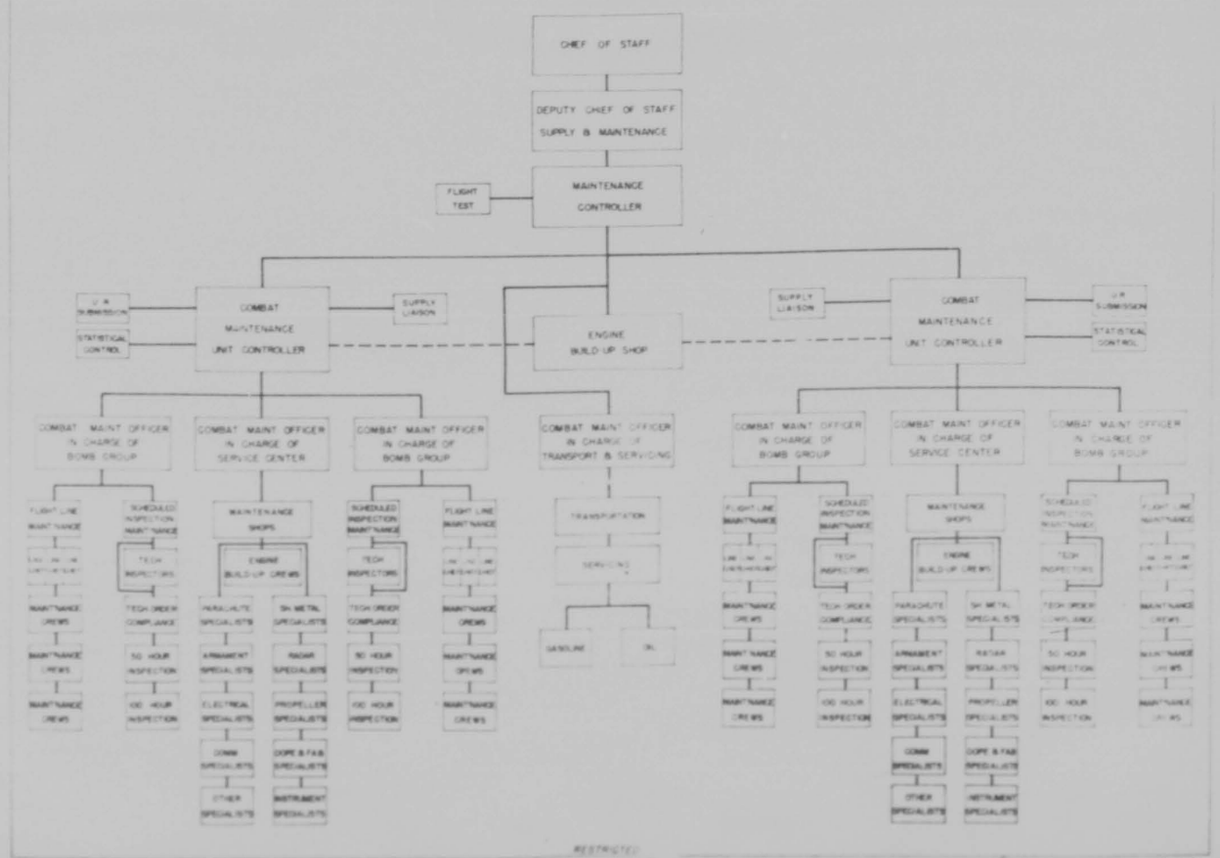
XXI BOMBER COMMAND

# TYPICAL WING COMBAT MAINTENANCE ORGANIZATION

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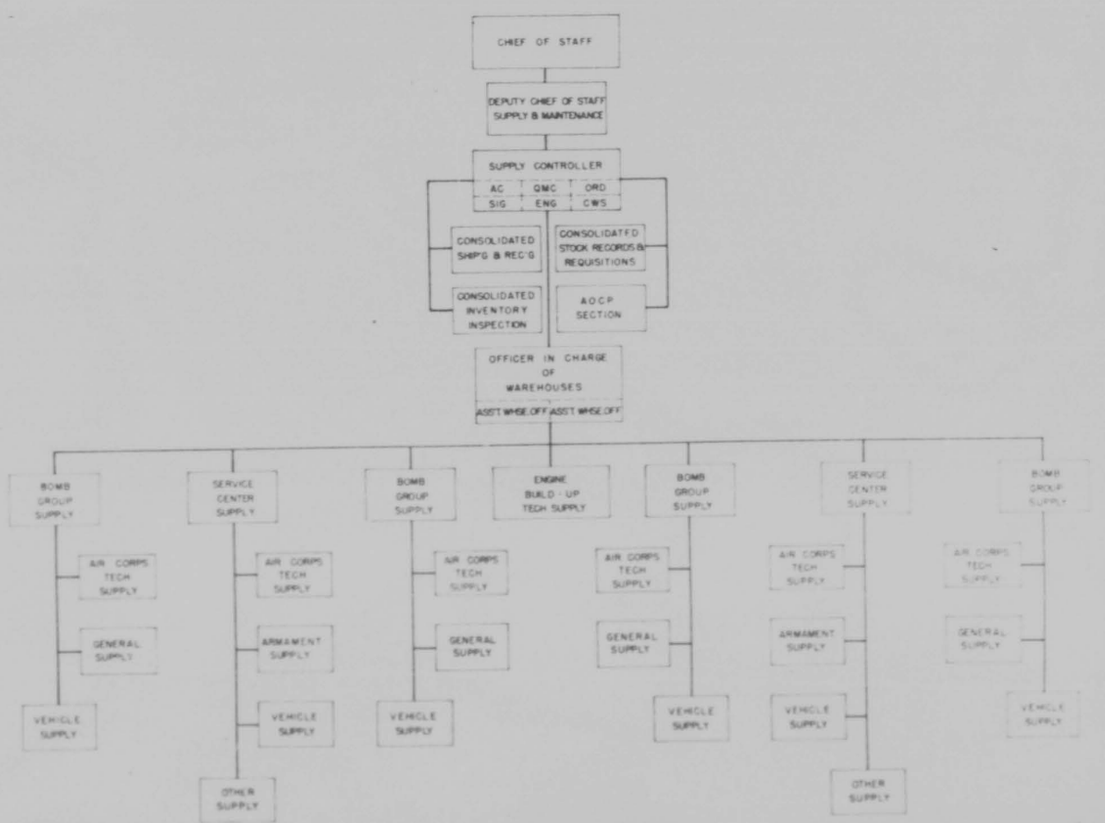
XXI BOMBER COMMAND

# TYPICAL WING CENTRALIZED SUPPLY ORGANIZATION

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XXI BOMBER COMMAND

# AIR BASE FACILITIES

20 APRIL 1945

| ISLAND & FIELD | | STRIP | RUNWAYS | | HARDSTANDS | | | | PARKING APRONS | | | AV. GAS STORAGE (IN BBLS.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | STAGE OF COMPLETION | E.C.D. | PLANNED | STAGE OF COMPLETION | NUMBER USE-ABLE | E.C.D. | PLANNED SQ. FT. | STAGE OF COMPLETION | E.C.D. | PLANNED | STAGE OF COMPLETION | E.C.D. |
| GUAM | DEPOT FIELD | | COMPLETE | | 84 | COMPLETE | 84 | | 1,200,000 | COMPLETE | | 25,000 | COMPLETE | |
| | | | | | | | | | 1,920,000 | COMPLETE | | | | |
| | NORTH FIELD | 1 | UNDER CONSTRUCTION | CORAL 1 MAY | 220 | 48 CORAL 71 ASPHALT COMPLETE | 103 | 60 - MAY | 600,000 | UNDER CONSTRUCTION | CORAL 1 MAY | 24,000 | COMPLETE | |
| | | 2 | ASPHALT 50% COMPLETE 150' WIDE | | | | | | 600,000 | COMPLETE | | | | |
| | NORTHWEST FIELD | 1 | CLEARED | 1 JUL | 200 | NOT STARTED | | 90 - 1 JUN | 600,000 | BEING CLEARED | 1 JUN | 24,000 | NOT STARTED | 1 JUL |
| | | 2 | UNDER CONSTRUCTION | 1 JUN | | | | 200 - 1 JUL | 600,000 | NOT STARTED | 1 JUL | | | |
| TINIAN | NORTH FIELD | 1 | CORAL COMPLETE 50% PAVED | PAVED 1 OCT | 170 | 170 CORAL COMPLETE | 170 | | 780,000 | 2 GP APRONS PAVED 1 GP APRON FINISHED (CORAL) 1 GP APRON UNDER CONST | | 48,900 | 48,950 COMPLETE 950 UNDER CONST | |
| | | 2 | CORAL COMPLETE | 1 OCT | | | | | | | | | | |
| | | 3 | CORAL COMPLETE | 1 OCT | | | | | 780,000 | CORAL COMPLETE | | | | |
| | | 4 | UNDER CONSTRUCTION | CONST HALTED | | | | | | | | | | |
| | WEST FIELD | 1 | CORAL COMPLETE | 1 OCT | 200 | 177 CORAL COMPLETE | 177 | 1 MAY | 780,000 | CORAL COMPLETE | | | | |
| | | 2 | 50% CORAL COMPLETE | CORAL 1 MAY PAVED 1 OCT | | | | | 780,000 | NOT STARTED | CORAL 1 MAY | | | |
| SAIPAN | ISELY FIELD | 1 | COMPLETE | | 176 | COMPLETE | 176 | | 570,000 | COMPLETE | | 19,000 | COMPLETE | |
| | | 2 | COMPLETE | | | | | | 600,000 | COMPLETE | | | | |
| IWO JIMA | CENTRAL FIELD | N | 1000' UNDER CONST | 1 JUN | 60 | NOT STARTED | | 15 - 1 JUNE | 2,000,000 * | UNDER CONST BEING USED FOR PARKING AREA | 1 JUN | 280,000 8,000 (READY TANKS AT FIELD) | 15% COMPLETE ISLAND PIPELINE STARTED | INDEF |
| | | S | 5000' UNDER CONST | 1 JUN | | | | 60 - 1 JULY | 2,000,000 * 600,000 ** | UNDER CONSTRUCTION | 1 JUL 1 JUN | | | |

**GENERAL INFORMATION**
**- RUNWAYS -**

WIDTH ——— 200 FEET
LENGTH ——— 8500 FEET, EXCEPT DEPOT FIELD, WHICH IS 7000 FT IN LENGTH
CONSTRUCTION: CORAL BASE PAVED WITH ASPHALT

**- NOTES -**

ABOVE INFORMATION DOES NOT INCLUDE SUB-SERVICE APRONS TO BE CONSTRUCTED AT NORTH FIELD, TINIAN, AND NORTH AND NORTHWEST FIELD, GUAM.
GASOLINE FACILITIES SHOWN ARE BULK STORAGE FOR ENTIRE ISLAND.
E.C.D. - ESTIMATED COMPLETION DATE.
* - REFUELING APRONS.
** - SERVICE APRON.

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# XXI BC SUPPLY CHANNELS

REQUISITIONS
SUPPLY
INFORMATION & COORDINATION

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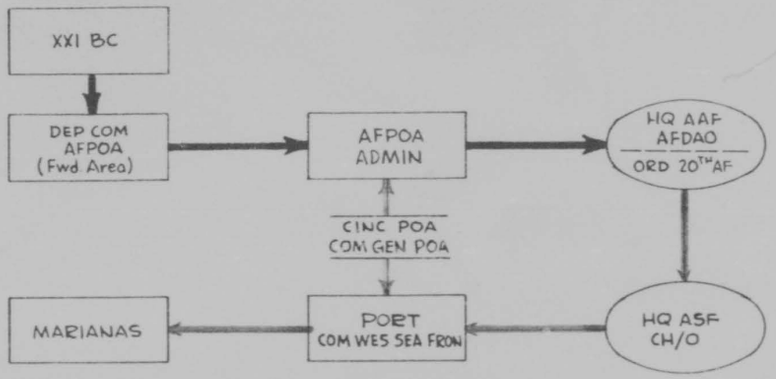
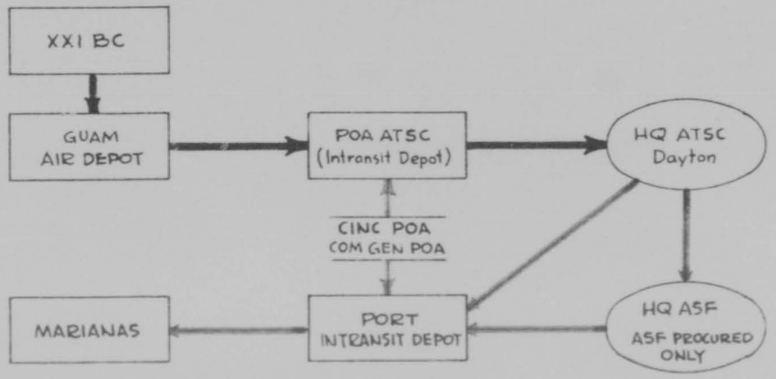
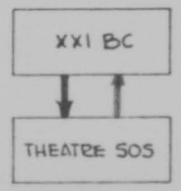



## ITEMS OF EXCLUSIVE AAF INTEREST




## COMMON ITEMS

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TROOP PROGRAM

BY AIR FORCE AND COMMAND

| NAME OF UNIT<br>T/O Number and Date<br>Numerical Designation of Units on Hand | | UNIT STRENGTH<br>Off | WO | EP | Agg |
|---|---|---|---|---|---|
| TWENTIETH AIR FORCE UNITS IN TENTH AND FOURTEENTH AIR FORCES | | | | | |
| Air Force, Hq & Hq Sq | | 0 | 0 | 0 | 0 |
| Twentieth | | | | | |
| Air Bulk Allotment to Twentieth/Tenth/Fourteenth Air Forces | | 36 | 3 | 500 | 539 |
| Incl III to AG Ltr | 25 Sep 44 | | | | |
| AG Ltr | 4 Nov 44 | | | | |
| (Plus 40 EM) AG Ltr | 9 Dec 44 | | | | |
| Allotment of Personnel to Twentieth/Tenth/ Fourteenth Air Forces | | 218 | 0 | 706 | 924 |
| AG Ltr | 4 Nov 44 | | | | |
| Bulk Allotment of Personnel to Twentieth/Tenth/ Fourteenth Air Forces | | 44 | 0 | 600 | 644 |
| Incl II to | | | | | |
| AG Ltr | 25 Sep 44 | | | | |
| AG Ltr | 4 Nov 44 | | | | |
| Bomber Command (VH) Hq & Hq Sq (Sp) | | 189 | 11 | 428 | 628 |
| 1-100-1S-2 Aug | 25 Apr 44 | | | | |
| C-1 | 6 Aug 44 | | | | |
| XX | | | | | |
| BombGroup (VH) Hq | | 34 | 1 | 75 | 110 |
| 1-112 Aug | 29 Jun 44 | | | | |
| C-4 | 6 Dec 44 | | | | |
| 40,444,462,468 | | | | | |
| Bomb Group(VH) Hq | | 32 | 1 | 75 | 108 |
| 1-112 Aug | 29 Jun 44 | | | | |
| C-3 | 31 Sep 44 | | | | |
| (Plus 1 Radar Observer Officer) | | | | | |
| Bomb Squadron (VH) | | 87 | 0 | 485 | 572 |
| 1-167 Aug | 17 Apr 44 | | | | |
| C-1 | 3 Aug 44 | | | | |
| (Aug 1 Col 29 plus Flight Engineers, less lines 84,85,87, Flight Engineers, 4E Pilots, Navigator-Bombardier-Radar, Aerial Gunners, Fire Control Spec Gunner & Radio Oper Mechanic) 25,44,45,676,677,678,768,769,770,792,793,794 | | | | | |

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# TROOP PROGRAM

## BY AIR FORCE AND COMMAND

| NAME OF UNIT<br>T/O Number and Date<br>Numerical Designation of Units on Hand | | UNIT STRENGTH<br>Off | WO | EP | Agg |
|---|---|---|---|---|---|
| TWENTIETH AIR FORCE UNITS IN TENTH AND FOURTEENTH AIR FORCES | | | | | |
| Air Force, Hq & Hq Sq | | 0 | 0 | 0 | 0 |
| Twentieth | | | | | |
| Air Bulk Allotment to Twentieth/Tenth/Fourteenth Air Forces | | 36 | 3 | 500 | 539 |
| Incl III to AG Ltr | 25 Sep 44 | | | | |
| AG Ltr | 4 Nov 44 | | | | |
| (Plus 40 EM) AG Ltr | 9 Dec 44 | | | | |
| Allotment of Personnel to Twentieth/Tenth/ Fourteenth Air Forces | | 218 | 0 | 706 | 924 |
| AG Ltr | 4 Nov 44 | | | | |
| Bulk Allotment of Personnel to Twentieth/Tenth/ Fourteenth Air Forces | | 44 | 0 | 600 | 644 |
| Incl II to | | | | | |
| AG Ltr | 25 Sep 44 | | | | |
| AG Ltr | 4 Nov 44 | | | | |
| Bomber Command (VH) Hq & Hq Sq (Sp) | | 189 | 11 | 428 | 628 |
| 1-100-1S-2 Aug | 25 Apr 44 | | | | |
| C-1 | 6 Aug 44 | | | | |
| XX | | | | | |
| BombGroup (VH) Hq | | 34 | 1 | 75 | 110 |
| 1-112 Aug | 29 Jun 44 | | | | |
| C-4 | 6 Dec 44 | | | | |
| 40,444,462,468 | | | | | |
| Bomb Group(VH) Hq | | 32 | 1 | 75 | 108 |
| 1-112 Aug | 29 Jun 44 | | | | |
| C-3 | 31 Sep 44 | | | | |
| (Plus 1 Radar Observer Officer) | | | | | |
| Bomb Squadron (VH) | | 87 | 0 | 485 | 572 |
| 1-167 Aug | 17 Apr 44 | | | | |
| C-1 | 3 Aug 44 | | | | |
| (Aug 1 Col 29 plus Flight Engineers, less lines 84,85,87, Flight Engineers, 4E Pilots, Navigator-Bombardier-Radar, Aerial Gunners, Fire Control Spec Gunner & Radio Oper Mechanic) | | | | | |
| 25,44,45,676,677,678,768,769,770,792,793,794 | | | | | |

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| | | | | | |
|---|---|---|---|---|---|
| AAF Combat Camera Unit<br>PAT 130 | 9 Nov 42 | 9 | 0 | 23 | 32 |
| Air Depot Group, Hq & Hq Sq<br>1-852-Aug<br>C-3<br>(Plus lines 123,124,125,126,127,130 & 131 of Col 12).<br><br>22 | 20 Jan 44<br>22 Jun 44 | 25 | 0 | 165 | 190 |
| Hq and Base Service Squadron, Air Service Group<br>1-452-T<br>C-2<br>(Plus Col 29 and line 35 of Col 20)<br><br>25,28,87,86 | 15 Apr 44<br>4 Nov 44 | 26 | 1 | 287 | 314 |
| Air Engineering Squadron<br>1-457-T Aug<br>C-3<br>(Aug by Cols 30-35)<br><br>35,39,349,355 | 15 Apr 44<br>21 Nov 44 | 11 | 1 | 246 | 258 |
| Air Materiel Squadron<br>1-458-T<br>C-3<br><br>578,584,585,589 | 15 Apr 44<br>21 Nov 44 | 7 | 1 | 134 | 142 |
| Depot Repair Squadron<br>1-857 Aug<br>C-2<br><br>97 | 15 Dec 43<br>24 May 44 | 13 | 0 | 356 | 369 |
| Depot Supply Squadron<br>1-858<br>C-2<br><br>91 | 25 Nov 43<br>4 Jul 44 | 7 | 0 | 124 | 131 |
| Air Transport Squadron (Mobile)(Sp)<br>1-57-S<br>C-1<br><br>1,2,3 | 29 Mar 44<br>11 May 44 | 76 | 0 | 286 | 362 |
| Photo Tech Unit<br>1-769<br>(Plus Cols 1-11)<br><br>10 | 19 Aug 44 | 34 | 1 | 64 | 99 |



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| | | | | | |
|---|---|---|---|---|---|
| Statistical Control Unit<br>1-797-S<br>37 | 16 Oct 43 | 12 | 0 | 57 | 69 |
| Historical Unit<br>20-12-S<br>(Col 10-Note "B" not Applicable)<br>17 | 3 Oct 44 | 2 | 0 | 2 | 4 |
| Photo Lab Bomb Group (VH)<br>1-119<br>11,12,13,14 | 15 Jul 44 | 1 | 0 | 20 | 21 |
| Chemical Company Air Operations<br>3-457 | 29 Sep 44 | 4 | 0 | 130 | 134 |
| Chemical Depot Company (Avn)<br>3-418 | 28 Feb 42 | 4 | 0 | 74 | 78 |
| Engineer Airborne Avn Battalion<br>5-455 | 4 May 43 | 28 | 1 | 478 | 507 |
| Engineer Avn Battalion<br>5-415, 5-416, 5-417 | 15 May 44 | 33 | 0 | 744 | 777 |
| Engineer AF Hq Company<br>5-800-2<br>(Less Cols 8-11) | 6 Sep 43 | 7 | 0 | 101 | 108 |
| Engineer Topo Company (Avn)<br>5-400 Aug<br>5-500<br>C-9<br>(1AE,1AF,1AG,1AJ,1AL, 1AP,all less line 101 T/O 5-500: 1MA less line 145)<br>948 | 1 Nov 43<br>31 July 43<br>10 Jun 44 | 10 | 0 | 150 | 160 |
| Medical Supply Platoon (Avn)<br>8-497<br>22 | 26 Jul 43 | 2 | 0 | 19 | 21 |
| Medical Dispensary (Avn)<br>8-450<br>C-1<br>224,225,226 | 27 Oct 43<br>22 Nov 43 | 4 | 0 | 24 | 28 |

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| | | | | | |
|---|---|---|---|---|---|
| Military Police Company(Avn)<br>19-217 1 May 42<br><br>1362 | | 4 | 0 | 97 | 101 |
| Ordnance Company Ammunition (Avn)<br>9-17 1 Apr 42<br><br>*1903 | | 6 | 0 | 173 | 179 |
| Quartermaster Truck Company (Avn)<br>10-517 18 Aug 43<br>C-1 16 Dec 43<br><br>2472,*1993,*2018 | | 3 | 0 | 99 | 102 |
| Quartermaster Platoon, Air Depot Group<br>10-427 17 Sep 43<br>C-1 29 Dec 43<br><br>422 | | 2 | 0 | 22 | 24 |
| Signal Company (Avn)(Less R.I.Platoon)<br>11-217 19 May 42<br>C-2 25 Apr 44<br>(Less Col 8(R.I.Platoon) Aug by Col DD less 1 E.M.each, lines 53 & 54, less lines 44 & 45, and IL of T/O 11-500, 22 Sep 44)<br><br>413 | | 12 | 0 | 192 | 204 |
| Signal Depot Company (Avn)<br>11-287 11 Apr 44<br>(Cols 12-18)<br><br>894 | | 9 | 1 | 179 | 189 |
| Signal Company Wing<br>11-247 1 Jul 42<br>(Aug by Cols DC, less 1 Enlisted Man each of lines 53 & 54; EJ less lines 44 & 45; IL of T/O 11-500, 22 Sep 44)<br><br>338 | | 8 | 0 | 119 | 127 |
| Signal Radio Maintenance Team (Avn)<br>11-357 26 May 44<br>C-1 21 Jun 44<br>(2 Teams B, 3 Teams D)<br><br>4 | | 4 | 0 | 25 | 29 |

* Negro Personnel

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| | | |
|---|---|---|
| TOTAL TWENTIETH AIR FORCE UNITS IN TENTH AND FOURTEENTH AIR FORCES | Officers | 2246 |
| | Warrant Officers | 32 |
| | Enlisted Personnel | 14073 |
| | Aggregate | 16351 |

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B-29 CREW COMPOSITION

Authorized crew for the B-29 type aircraft is as follows:

Pilot (1093)
Co-pilot (1093)
Navigator (1034)
Bombardier (1035)
Radar observer, bombardment (0142)
a/ Flight engineer (1028)
RCT gunner (580)
Aerial gunner (611)
b/ Armorer gunner (612)
Radio operator mechanic (2756)
b/ Electrical mechanic gunner (1685)

a. Enlisted flight engineer (737) may be substituted.

b. Aerial gunner (611) may be substituted.

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**B-29 OPERATIONAL LOSSES OPERATING FROM MARIANAS' AND FORWARD BASES IN CHINA**

I. In the XX Bomber Command a total of 158 B-29's have been damaged or lost to enemy action (27 damaged). Of this total figure, 5 aircraft, or 3%, lost have been attributed fully or in part to navigation error. The following facts have been determined as to the direction of error in navigation:

(a) None have been on course and short of base.

(b) None have been on course and beyond base.

(c) 100% have been off course.

B-29 losses attributed to navigation error are comparatively small.

Following is breakdown of other B-29 losses in the XX Bomber Command:

(a) 46% result of power plant failure.

(b) 35% result of personnel failure.

(c) 12% result of weather.

(d) 3% result of navigation

(e) 4% undetermined.

II. Information concerning losses of XXI Bomber Command B-29's operating out of the Marianas.

Following are percentages of losses of B-29 aircraft attributed to navigation:

(a) On course but short of base, 4.05%

(b) On course but beyond base, 0.

(c) Off course, 2.79%.

NOTE: Radio contact was established with B-29 aircraft of the XXI Bomber Command lost because of navigation failure. 2 aircraft had no Loran facilities; 2 aircraft had one station Loran facilities; and 1 aircraft had 2 station facilities.

Following is the complete breakdown of B-29 losses in Marianas:

(a) 6.88% navigation error.
(b) 67.9% loss other causes.
(c) 25.3% unknown.

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# XX BOMBER COMMAND PLANNING FACTORS

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## COMBAT OPERATIONS *

| | | |
|---|---|---|
| 1. | % of Combat aircraft that can be expected to become airborne in Rear Area | - 87 % |
| 2. | % of Rear Area airborne aircraft that can be expected to arrive in Forward Area | - 96 % |
| 3. | % of aircraft arriving in Fwd Area that can be expected to become airborne | - 93 % |
| 4. | % of airborne aircraft that can be expected to bomb primary target | - 83 % |
| 5. | % of combat aircraft in theater than can be expected to bomb primary target | - 64 % |
| 6. | % of Mission aircraft that can be expected to return to Rear Area by D Day plus 3 | - 80 % |

* Based on having at least 10 days between maximum efforts and assuming movement to forward area begins at least by D-Day minus 3. These rates do not apply to "double" missions.

## FORWARD AREA LOGISTICAL REQUIREMENTS

| | | |
|---|---|---|
| 1. | Monthly requirements for 312th Fighter Wing | - 1500 tons |
| 2. | Monthly requirements to XX BC overhead | - 475 tons |
| 3. | Incremental tonnage required per sortie staged through the China bases | - 22 tons |
| 4. | Incremental tonnage required per China based sortie | - 25 tons |

## TRANSPORT OPERATIONS

| | | |
|---|---|---|
| 1. | B-29 Tankers - average off-load | - 250 gals. |
| | average No. of trips per mo. per tanker | - 65 trips |
| 2. | C-46 Squadrons - net deliveries per squadron per month when operated by XX BC | - 400 tons |
| | Net deliveries per squadron per month when delivered by ATC | - 800 tons |
| 3. | C-109 tankers - estimated net deliveries per month when operated by ATC | - 75 tons |

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# TWENTIETH AIR FORCE OPERATIONAL PLANNING FACTORS

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## 1. Estimated Sortie Effort

Following is the estimate of B-29 combat sortie effort per month per group of 24 U.E. aircraft:

Combat Sortie Per Month Per Group of 24 aircraft

| | XXI BC | XX BC |
|---|---|---|
| First Month | 120 | 192 |
| Second Month | 240 | 384 |
| Following months | 240 | 384 |

Flying Hours per Month per Aircraft

| | | |
|---|---|---|
| Second Month | 110 | 95 |
| Following Months | 110 | 95 |

NOTE: See the Estimated Bomb Load and Range Charts for the Bomb Load that can be carried out of our various VLR bases.

## 2. Long Range Planning Factors

Two combat crews per UE aircraft
10 sorties per UE aircraft per month in the XXI Bomber Command
16 sorties per UE aircraft per month in the XX Bomber Command
15 hours per sortie in the XXI BC.
8 hours per sortie in the XX BC
10 tons of bombs per sortie for both commands
1.6% crew attrition per sortie for the XXI BC
1.4% crew attrition per sortie for XX BC
2% per sortie aircraft attrition for both commands

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## TWENTIETH AIR FORCE ESTIMATED SORTIE EFFORT

| DATE | XXI BOMBER COMMAND | | | | | |
|---|---|---|---|---|---|---|
| | GROUPS | | U.E. A/C | | SORTIES | |
| | 1st Mo. in Thea | 2nd & Ff. Mos in Theater | | | | |
| MAY | 4 | 12 | 512 | (384) | 4480 | (3360) |
| JUN | 2 | 16 | 576 | (432) | 5440 | (4080) |
| JULY | 2 | 18 | 640 | (480) | 6080 | (4560) |
| AUG | | 20 | 640 | (512) | 6400 | (5120) |
| SEP | | 20 | 640 | (544) | 6400 | (5440) |
| OCT | | 20 | 640 | (608) | 6400 | (6080) |
| NOV | | 20 | 640 | (640) | 6400 | |
| DEC | | 20 | 640 | | 6400 | |
| JAN | | 20 | 640 | | 6400 | |
| FEB | | 20 | 640 | | 6400 | |
| MAR | | 20 | 640 | | 6400 | |
| APR | | | | | | |

| | XX BOMBER COMMAND | | | | | |
|---|---|---|---|---|---|---|
| | GROUPS | | U.E. A/C | | SORTIES | |
| | 1st Mo. in Thea | 2nd & Ff Mos in Theater | | | | |
| SEP | 2 | | 64 | (48) | 512 | ( 384) |
| OCT | 4 | 2 | 192 | (144) | 2048 | (1536) |
| NOV | 2 | 6 | 256 | (224) | 3584 | (3200) |
| DEC | 2 | 8 | 320 | | 4608 | |
| JAN | 2 | 10 | 384 | | 5632 | |
| FEB | 4 | 12 | 512 | | 7168 | |
| MAR | 4 | 16 | 640 | | 9216 | |
| APR | | 20 | 640 | | 10240 | |

### TOTAL TWENTIETH AIR FORCE SORTIES

| | | | | | |
|---|---|---|---|---|---|
| MAY | 4480 | (3360) | NOV | 9984 | (9600) |
| JUNE | 5440 | (4080) | DEC | 11008 | |
| JULY | 6080 | (4560) | JAN | 12032 | |
| AUG | 6400 | (5120) | FEB | 13568 | |
| SEPT | 6912 | (5824) | MAR | 15616 | |
| OCT | 8448 | (7616) | APR | 16640 | |

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ASSUMPTIONS

(1) 40 Group Program

(2) 24 U.E. a/c per Group to be augmented to 32 U.E. starting August 1945.

(3) Activity rate: XXI BC - 1st Mo in thea - 5 sorties per U.E.
2nd & ff mos " - 10 sorties per U.E.

XX BC - 1st Mo in thea - 8 sorties per U.E.
2nd & ff mos " - 16 sorties per U.E.

NOTE:

The figures in parentheses represent the planned U.E. a/c on hand and the sorties that the XXI Bomber Command would accomplish if the Bomber Command were brought into line with present VHB AAF planning factors and allocated only 24 U.E. aircraft per Group; but as the XXI Bomber Command has additional aircraft on hand, the sortie effort must be computed on the basis of aircraft available. Therefore, the figures not in parentheses represent a more accurate estimate of the capabilities of the XXI Bomber Command through September 1945.

In August of 1945 the Bomb Groups will be augmented to four Squadrons and the situation will right itself as there will then be 32 U.E. aircraft per Group.

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Twentieth Air Force

B-29 Gas Consumption Rates

| | Gas Consumption Per Flying Hours- | |
|---|---|---|
| Training Missions | 505 gals. | * |
| Movement to Theater | 421 gals. | ** |
| Transport Missions - Tactical a/c | 525 gals. | *** |
| - Tanker a/c | 458 gals. | *** |
| Combat Missions | 519 gals. | **** |

* Based on Second Air Force October operations during which B-29 aircraft consumed 11,275,000 gals. of gasoline on 31,150 flying hours. Training aircraft of the Second Air Force are limited to 105,000 lbs. during training.

** Based on movement of 145 aircraft from Salina, Kansas, to Kharagpur, India, during April and May of 1944. Average altitude - 10,000 to 12,000 feet. Very few climbs over 12,000 ft.

*** Based on XX Bomber Command transport operations between India and China. Average gross weight of both tactical and tanker aircraft on take-off from India - 51,500 lbs. Average weight at take-off on return to India: Tactical aircraft - 96,000 lbs; Tanker aircraft - 92,000 lbs. Climb on both legs of trip to 18,000 to 22,000 feet.

**** Based on XX Bomber Command September combat missions which included 219 sorties against Manchuria, bombing altitude 20,000 to 26,000 ft. Weight of aircraft limited to 132,500 lbs. at take-off, because of runways at Chengtu.

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## VHB CONVERSION PROGRAM

The VHB conversion plan is now set up to utilize only units returning from the European Theater. The plan converting three Heavy Groups of the South Pacific in the Theater has been discarded.

Following is the schedule of units returning from Europe to be reconverted and deployed as VHB Groups to the Pacific:

| | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
|---|---|---|---|---|---|---|---|---|---|
| Date Air Echelon Deployed in Theater | | | 1 | 1 | 2 | 2 | 2 | 4 | 4 |
| Date Ground Echelon of abv Flight Echelons are ready to depart U.S. | 1 | 1 | 2 | 2 | 2 | 4 | 4 | | |

## AUGMENTATION OF VHB GROUPS

Commencing August 1945, VHB Groups will be augmented to include four Squadrons. Each Squadron will consist of eight UE aircraft plus 50% reserve. This will provide a VHB Group with forty-eight B-29 aircraft. The first 30 VHB Groups of the Twentieth Air Force will be augmented in the Theater and the remaining ten Groups in the continental U. S. The following is the schedule of augmentation in the Theater of the thirty Groups.

| Number of Groups | Date of Activation in Theater | Readiness Date of Add'l Personnel at POE |
|---|---|---|
| 4 | 20 Aug 45 | 1 Aug 45 |
| 4 | 20 Sep 45 | 1 Sep 45 |
| 8 | 20 Oct 45 | 1 Oct 45 |
| 8 | 20 Nov 45 | 1 Nov 45 |
| 6 | 20 Dec 45 | 1 Dec 45 |



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# TACTICAL PLANNING CHARACTERISTICS & PERFORMANCE CHART

| MODEL & BLOCK NO. | ENGINE & PROP. | | | SIZE | WT. | CREW | FUEL | | ARMAMENT | | | | BOMBS ~~CARGO PASS~~ | | | RADIO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | ENGINE MFGR. MODEL SUPERCHARGER PROP MFGR. TYPE | B.H.P./ALT. T-TAKE-OFF M-MILITARY C-CONTINUOUS | S- SPAN L-LENGTH H-HEIGHT T-TREAD W-WING AREA | B-BASIC C-COMBAT ~~D-RECO LIM.~~ W-WAR MAX. | COMBAT | TANK TYPE OR LOCATION | NO. TANKS & CAPACITY U.S. GAL. | NO. GUNS & CALIBER | RDS. PER GUN | LOCATION & TYPE | INTERNAL NO. & SIZE OR STATION | EXTERNAL NO. & SIZE OR CAPACITY | MAX LOAD LB. | TYPE |
| B-29-1 to -29 (BG)<br>B-29-5-54<br>B-29-5-60 | 4 | WRIGHT R-3350-23, -23A, -41, -57, -59 TURBO HAMILTON STD. 16'7"DIA. - 4BL. F.F., HYDROMATIC | T 2200/ S L<br>M 2200/25000<br>WW 2300/ -(C)<br>C 2000/25000 | S 141'3"<br>L 99'<br>H 29'7"<br>T 31'6"<br>W 1739 SQ.' | B 71600<br>C 120000<br>~~D-135000~~<br>W 135000 | 10 | OUTBD.-WINGS<br>INBD. -WINGS<br>BOMB BAY | 4-2735<br>8-2875<br>4-640<br>6168 TOT. | 1-20MM<br>2)<br>2) .50<br>2)<br>2)<br>2) | 100<br>1000<br>1000<br>1000<br>1000<br>1000 | TAIL-BE, TYPE B<br>UPPER FORE TUR.<br>UPPER REAR TUR.<br>LOWER FORE TUR.<br>LOWER REAR TUR.<br>TAIL POWER BT. | 4-4000<br>8-2000<br>12-1600<br>12-1000<br>40- 500 | NONE | 20000 | SEE NOTE (A) |
| B-29-25 to -65 (BG)<br>B-29-5 to -45 (BG)<br>B-29-1 to -20 (BG) | 4 | AS ABOVE | AS ABOVE | AS ABOVE | AS ABOVE | 10 | OUTBD.-WINGS<br>INBD. -WINGS<br>CENTER-WINGS<br>BOMB BAY | 4-2735<br>8-2875<br>4-1515<br>4-640<br>9665 TOT. | 1-20MM b)<br>4) a<br>2) .50<br>2)<br>2)<br>2) | 100<br>675<br>1000<br>1000<br>1000<br>1000 | TAIL-BE, TYPE B<br>UPPER FORE TUR.<br>UPPER REAR TUR.<br>LOWER FORE TUR.<br>LOWER REAR TUR.<br>TAIL POWER BT. | A 8 | A 8 | 0 V | B |
| B-29A-5 to -45 (BG) | 4 | AS ABOVE | AS ABOVE | AS ABOVE | AS ABOVE | 10 | OUTBD.-WINGS<br>INBD. -WINGS<br>CENTER-WINGS<br>BOMB BAY | 4-2735<br>8-2875<br>3-1120<br>4-640<br>9885 TOT. | 1-20MM b)<br>2)<br>2) .50<br>2)<br>2)<br>2) | 100<br>1000<br>1000<br>1000<br>1000<br>1000 | TAIL-BE, TYPE B<br>UPPER FORE TUR.<br>UPPER REAR TUR.<br>LOWER FORE TUR.<br>LOWER REAR TUR.<br>TAIL POWER BT. | A 8 | A 8 | 0 V | B |
| | | | T<br>M<br>C | S<br>L<br>H<br>T<br>W | B<br>C<br>W | | | | | | | | | | | |
| | | | T<br>M<br>C | S<br>L<br>H<br>T<br>W | B<br>C<br>W | | | | | | | | | | | |

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| MODEL & BLOCK NO. | TAKE OFF & LANDING (HARD SURFACE - NO WIND) | | | | | | HIGH SPEED & CLIMB (AT NORMAL COMBAT WEIGHT) | | | | | | | | | RANGE & ENDURANCE (STATUTE AIR MILES - NO WIND - NO ALLOWANCE FOR RESERVE) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GROSS WEIGHT | TO CLEAR 50' | | LANDING SPEED | GROUND-RUN | | WEIGHT | STD ALT | WAR EMERG. | | MIL. POWER | | MAX. CONTIN. POWER | | | TAKE OFF WEIGHT | BOMB GROUP | TOTAL FUEL | MAX. CONTINUOUS POWER | | | | MAX. CRUISE POWER | | | | LONG RANGE | |
| | | T.O. DIST | LAND. DIST | | T.O. DIST | LAND. DIST | | | HIGH SPEED | RATE OF CLIMB | HIGH SPEED | RATE OF CLIMB | HIGH SPEED | RATE OF CLIMB | TIME TO CLIMB | | | | AT 10,000 FT. | | AT 25,000 FT. | | AT 10,000 FT. | | AT 25,000 FT. | | AT 10,000 FT. | |
| | | | | | | | | | | | | | | | | | | | RANGE | ENDUR. | RANGE | ENDUR. | RANGE | ENDUR. | RANGE | ENDUR. | RANGE | ENDUR. |
| | LB | FT | FT | M.P.H. | FT | FT | LB | FT | M.P.H. | FT/MIN. | M.P.H. | FT/MIN. | M.P.H. | FT/MIN. | MIN | LB | LB | U.S. GAL | MILES | HOURS | MILES | HOURS | MILES | HOURS | MILES | HOURS | MILES | HOURS |
| B-29-1 to -20 (MA) | 80000 | - | - | - | - | - | 120000 | 30000 | 346* | 600* | 342 | 350* | 328 | 150 | 72.0 | 134000 | NONE | 8166 | - | - | - | - | - | - | - | - | 4150 | 19.1 |
| | 90000 | - | 4350 | 109* | - | 3200 | | 25000 | 334* | 550* | 329 | 475* | 313 | 300 | 52.0 | 133000 | 8000 | 6888 | 1900 | 6.5 | 2000 | 6.6 | 3150[b] | 12.8 | - | - | 3400 | 15.3 |
| B-29-1-BA | 100000 | 4650 | - | 110* | 3100 | - | | 20000 | 333* | 675* | 328 | 575* | 314 | 625 | 58.0 | 132000 | 8000 | 5606 | 1550 | 5.2 | 1650 | 5.2 | 2700 | 10.9 | - | - | 3000 | 14.0 |
| | 110000 | 5700 | - | 115* | 3850 | - | | 15000 | 317* | 750* | 312 | 660* | 300 | 500 | 36.0 | 128000 | 12000 | 5608 | 1550 | 5.2 | 1600 | 5.1 | 2600[b] | 10.7 | - | - | 2700 | 12.5 |
| B-29A-1-BN | 120000 | 7150 | - | 120* | 6900 | - | | 10000 | 308* | 825* | 305 | 725* | 290 | 575 | 16.0 | | | | | | | | | | | | | |
| | 135000 | 9900 | - | - | 8700 | - | | 5000 | 294* | 700* | 289 | 600* | 276 | 650 | 8.0 | | | | | | | | | | | | | |
| B-29m25 to -60 (BW) | | | | | | | | | | | | | | | | | | | ALL CONDITIONS SHOWN ABOVE CAN BE USED PLUS: | | | | | | | | | |
| B-29-5 to -40 (BA) | | A S | | A B O | | V E | | A | S | | A | S | O | V | E | 134000 | NONE | 8205 | - | - | - | - | - | - | - | - | 4800 | 19.2 |
| B-29-1 to -20 (MO) | | | | | | | | | | | | | | | | 129000 | 4000 | 6985 | 1900 | 6.5 | 2000 | 6.5 | 3500[b] | 13.4 | - | - | 3500 | 16.3 |
| | | | | | | | | | | | | | | | | 135000 | 10000 | 6985 | 1900 | 6.5 | 1900 | 6.5 | 3050[b] | 12.6 | - | - | 3350 | 14.9 |
| B-29A-5 to -45 (BW) | | | | | | | | | | | | | | | | | | | ALL CONDITIONS IN FIRST GROUP CAN BE USED PLUS: | | | | | | | | | |
| | | A S | | A B O | | V E | | A | S | | A | S | O | V | E | 133000 | NONE | 8008 | - | - | - | - | - | - | - | - | 4050 | 18.6 |
| | | | | | | | | | | | | | | | | 128000 | 4000 | 6788 | 1900 | 6.4 | 1950 | 6.3 | 3200 | 13.1 | - | - | 3400 | 15.7 |
| | | | | | | | | | | | | | | | | 134000 | 10000 | 6788 | 1850 | 6.3 | 1950 | 6.3 | 3000 | 12.2 | - | - | 3250 | 14.7 |

NOTES:

(A) AN/ARC-8 SCR-269G RC-43/193 RC-109 AN/ARN-5 RC-36 SCR-695 SCR-578 SCR-718 AN/APS-13 RANGE AN/ASA-1 AN/ARN-1 PROVISIONS FOR: AN/APN-6 SCR-522 — LIAISON SET; COMPASS (OF AN/ARN-7); MARKER BEACON; GLIDE PATH RECEIVER; LOCALIZER RECEIVER; INTERPHONE (OF AN/AIC-2); IFF; EMERGENCY TRANSMITTER; HIGH ALTITUDE ALTIMETER; HIGH ALTITUDE RADAR; ADF; STATIC DISCHARGER; ID ADAPTER (SOME PLANES ONLY); LORAN; VHF (SOME PLANES ONLY)

Starred FIGURES ARE PRELIMINARY; SUBJECT TO REVISION AFTER FLIGHT CHEC

(B) HIGHER LOADINGS ARE STRUCTURALLY POSSIBLE BUT ARE IMPRACTICAL BECAUSE POWER AVAILABLE WOULD BE INSUFFICIENT FOR TACTICAL OPERATION.

(C) WAR EMERGENCY POWER APPLICABLE ONLY TO ENGINES WITH SUITABLE PROPELLERS AND GOVERNORS.

MANUFACTURED BY MARTIN (Omaha) "MO"; BOEING (Wichita) "BW"; BOEING (Renton) "Re" & BELL (Atlanta) "Ba"

** [b] MAX. CRUISE POWER MUST BE EXCEEDED BY USING AUTO RICH UNTIL AIRCRAFT WEIGHT DECREASES TO APPROX. 125000 LB.

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Detailed Assumptions

R-3350 ENGINE REQUIREMENTS

1. SPARE ENGINE STOCK LEVEL

| | | |
|---|---|---|
| Second Air Force | - | one month |
| CBI | - | three months |
| Other Theatres | - | one month |

2. THEATER OVERHAUL

| | | |
|---|---|---|
| Bengal Air Depot | - | 60 engines per month only beginning in 1945 |

3. ENGINE TIME BETWEEN OVERHAULS

200 hours in theaters
300 hours in United States

4. FLYING TIME PER MONTH

| | |
|---|---|
| XX BC | - 111 hours per operational B-29 (60% operational) |
| XXI BC | - 90 hours the first month increasing to 153 hours in third month per operational B-29 (50% operational) |
| XXII BC, etc. | - 153 hours per operational B-29 (50% operational) |
| U.S. Training | - 150 hours per month per B-29 on hand |

5. FLOW TIME

| | |
|---|---|
| CBI | - 20 days from engine plant to POE<br>40 days from POE to Kharagpur<br>50 days from theater depot to U. S. port<br>50 days from U. S. port thru U. S. overhaul facility and back to POE |
| All other Theaters | - 20 days from engine plant to POE<br>30 days from POE to theater<br>40 days from theater to U. S. Port<br>50 days from U. S. port thru U. S. overhaul facility and back to POE |
| Second Air Force | - 20 days from engine plant to Second Air Force<br>50 days from Second Air Force thru overhaul facility and back to Second Air Force |

6. LOSS FACTORS

| | | |
|---|---|---|
| Theater | - | 10% engines pulled per month |
| U. S. | - | 5% engines pulled per month |

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# R3350 ENGINE LIFE
(as of 20 Feb. 1945)

## I.-- AVERAGE LIFE

| | | | |
|---|---|---|---|
| 1. | New Modified Engine - XX B.C. | - | 250-260 hours |
| 2. | New Modified Engine - XXI B.C. | - | 240-250 hours |
| 3. | OCAD Overhauled Modified Engine - XX B.C. | - | 140-150 hours |
| 4. | Unmodified Engine - XX B.C. | - | 155-165 hours |

## II. MORTALITY TABLE for NEW MODIFIED ENGINES
(Cumulative % of Engines Removed)

| No. of HOURS | XX B.C. a/ | XXI B.C. b/ |
|---|---|---|
| 0-20 | 1 | 1 |
| 21-40 | 2 | 3 |
| 41-60 | 3 | 5 |
| 61-60 | 4 | 7 |
| 81-100 | 5 | 10 |
| 101-120 | 6 | 13 |
| 121-140 | 8 | 17 |
| 141-160 | 12 | 21 |
| 161-180 | 14 | 26 |
| 181-200 | 18 | 32 |
| 201-220 | 22 | 40 |
| 221-240 | 31 | 49 |
| 241-260 | 38 | 58 |
| 261-280 | 59 | 68 |
| 281-300 | | 77 |
| 301-320 | | 84 |
| 321-340 | | 91 |
| 341-360 | | 96 |
| 361-380 | | 98 |
| 381-400 | | 100 |

a/. Actual data based on experience with 758 engines, 625 of which were still installed as of 20 February.

b/. Smooth rate estimated from experience with 1762 engines, 1452 of which were still installed as of 20 February.

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EXHIBIT III

B-29 HOURS IN MAINTENANCE PER HOUR FLOWN

(Monthly Averages)

| | 1944 | | | | | | | | | 1945 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb* | Average |
| CCTS | | | | | | | | | | | | |
| Clovis | 14.5 | 7.6 | 7.6 | 10.2 | 6.1 | 6.0 | 4.8 | 7.9 | 8.5 | 6.0 | 3.6 | 6.7 |
| Alamogordo | - | 3.5 | 4.2 | 5.9 | 5.4 | 6.6 | 6.3 | 5.4 | 4.6 | 4.4 | 3.7 | 5.5 |
| Pyote | - | - | - | 5.5 | 5.4 | 5.0 | 6.6 | 7.2 | 9.1 | 3.8 | 4.8 | 5.7 |
| Davis | - | - | - | - | - | - | - | - | - | 4.9 | 3.9 | 4.4 |
| Total | 14.5 | 7.2 | 6.3 | 7.8 | 5.7 | 6.2 | 5.7 | 6.9 | 7.2 | 4.7 | 4.0 | 6.0 |
| Walker | 8.5 | 3.1 | 3.4 | 5.2 | 5.0 | 5.9 | 18.7 | 5.5 | 4.7 | 6.8 | 4.3 | 5.6 |
| Harvard | - | - | 13.5 | 9.2 | 4.1 | 5.7 | 5.6 | 8.0 | 5.5 | 5.7 | 5.9 | 5.8 |
| Great Bend | 9.5 | 4.9 | 4.1 | 4.2 | 3.4 | 5.7 | 9.0 | 8.2 | 10.4 | 4.3 | 10.2 | 6.0 |
| Grand Island | - | - | 4.3 | 5.2 | 7.9 | 5.5 | 5.6 | 5.0 | 3.6 | 4.5 | 5.5 | 4.9 |
| Smoky | 21.7 | 5.1 | 5.7 | 6.7 | 5.6 | 6.5 | 28.0 | 8.6 | 12.1 | 6.5 | 4.5 | 7.8 |
| Pratt | 6.2 | 3.4 | 4.9 | 6.1 | 4.6 | 5.2 | 6.1 | 6.0 | 5.6 | 2.8 | 10.2 | 5.7 |
| McCook | - | - | - | 15.7 | 5.5 | 6.0 | 7.1 | 7.2 | 12.4 | 11.7 | 9.3 | 8.6 |
| Fairmont | - | - | 12.3 | 8.7 | 5.4 | 4.5 | 6.2 | 6.1 | 6.1 | 7.1 | 4.9 | 6.2 |
| Total | 11.3 | 4.1 | 4.6 | 5.7 | 4.7 | 5.6 | 9.0 | 7.0 | 6.9 | 5.6 | 6.0 | 6.0 |
| GRAND TOTAL | 11.6 | 5.3 | 5.2 | 6.6 | 5.1 | 6.4 | 7.4 | 7.0 | 7.0 | 5.2 | 5.2 | 6.0 |

s of 23 February 1945

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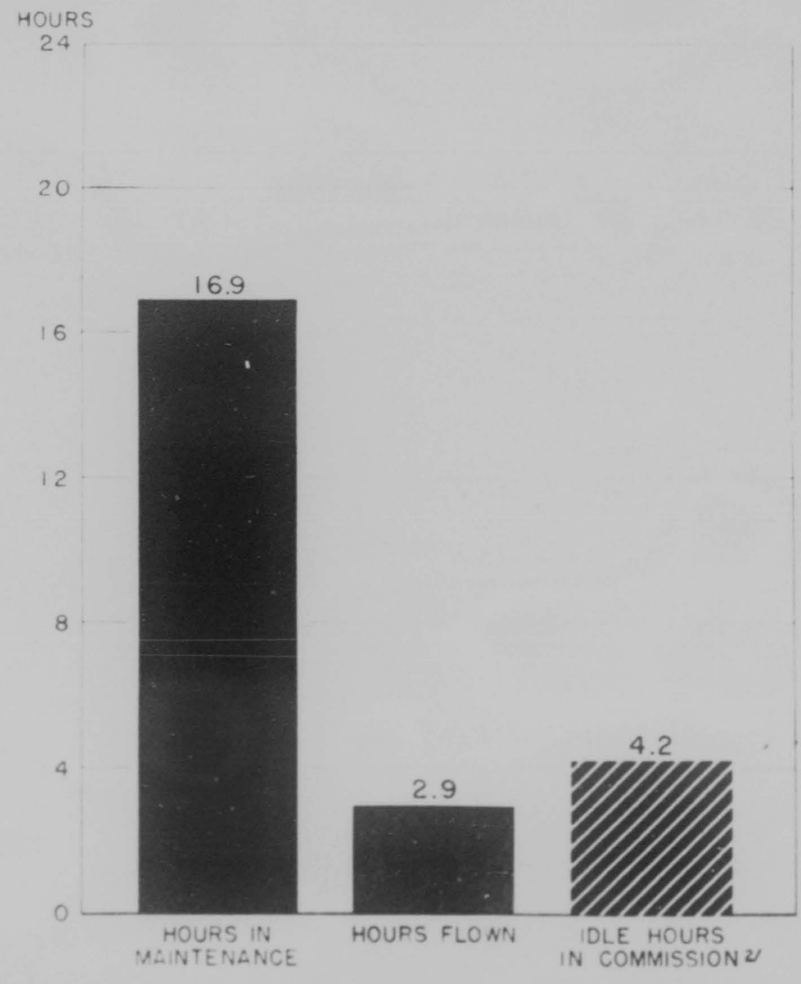
EXHIBIT - 1

# Typical B-29 Day in Second Air Force Training Bases

(October 1944 - February 1945) 1/




1/ To 23 February 1945
2/ Lost due to Weather and Other Causes

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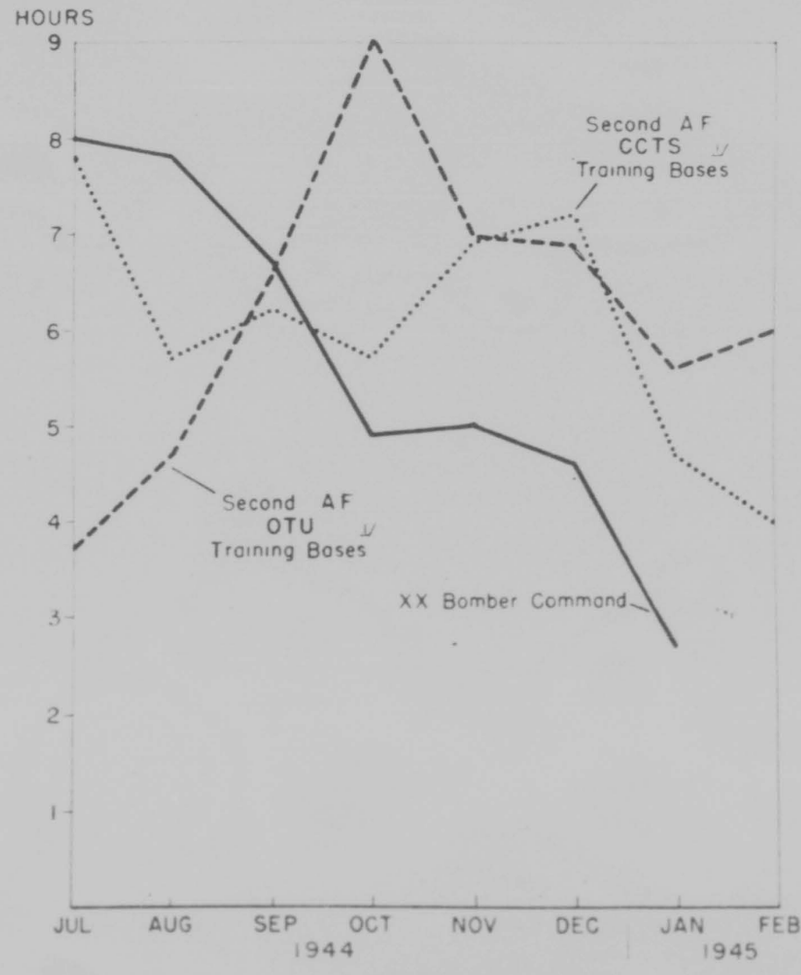
EXHIBIT - 2

# B-29 Hours in Maintenance Per Hours Flown




1/ B-29 Airplanes at Training Bases Only

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## STATUS OF VLR FIGHTER PROJECT AS OF MARCH 1, 1945

I. P-47N Fighter Groups

1. Unit Readiness Dates and Movement

| | |
|---|---|
| 301st Fighter Wing, Hq & Hq Sq | 1 April |
| 413th Fighter Group | 1 March |
| 337th Service Group Special | 1 March |
| 507th Fighter Group | 1 March |
| 557th Service Group Special | 15 March |
| 414th Fighter Group | 20 April* |
| 555th Service Group Special | 20 April* |
| 305th Signal Company Wing | 1 April |
| 6th Statistical Control Detachment | 1 March |
| 92nd Air Depot Group | 1 April |
| 1902nd Engineer Aviation Battalion | 15 January |
| 1903rd Engineer Aviation Battalion | 15 January |
| 1924th Engineer Aviation Battalion | 1 April |
| 1388th Military Police Company, Aviation | 1 April |
| 71st Repair Squadron, Air Depot Group | 1 April |
| 319th Supply Squadron, Air Depot Group | 1 April |
| 506th Fighter Group | 10 February |
| 81st Air Service Group (this Group will be P-51D equipped) | 1 February |

*Telecon dated 1 March indicates probable postponement of readiness dates until 1 May.

2. The following Fighter Groups now assigned to AAFPOA are being equipped with P-47N's and are being trained in the theater:

318th Fighter Group
364th Service Group Special

II. The following two Groups also now assigned to AAFPOA are being equipped with P-51D's.

15th Fighter Group
386th Service Group Special

21st Fighter Group
363rd Service Group Special

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III. P-47D Fighter Groups

The 508th Fighter Group (P-47D) arrived Hawaii 9 January to take over air defense. It is assigned to the Twentieth Air Force and attached for administration and operational control to AAFPOA. At a later date this group will be re-equipped with P-47N's. The 556th Service Group Special which will service the 508th Fighter Group has a readiness date of 15 March.

IV. Special Equipment for Aircraft

1. P-47N's.

(a) G1 automatic pilots
(b) Catapult Hooks
(c) IFF
(d) Anti-G valve assembly
(e) AN/ARA-8 homing device will be installed in the aircraft in the theater*

*Aircraft of the 318th Group were not equipped with catapult hooks.

2. P-51D's.

(a) Catapult hooks
(b) IFF
(c) AN/ARA-8

U. E. aircraft of the 506th Fighter Group and some of the reserve aircraft have had IFF installed in aircraft while in the States. The G1 automatic pilot will not be installed in the P-51. Grumman automatic pilots, which are considerably lighter, will be available for the P-51's before mid-summer.

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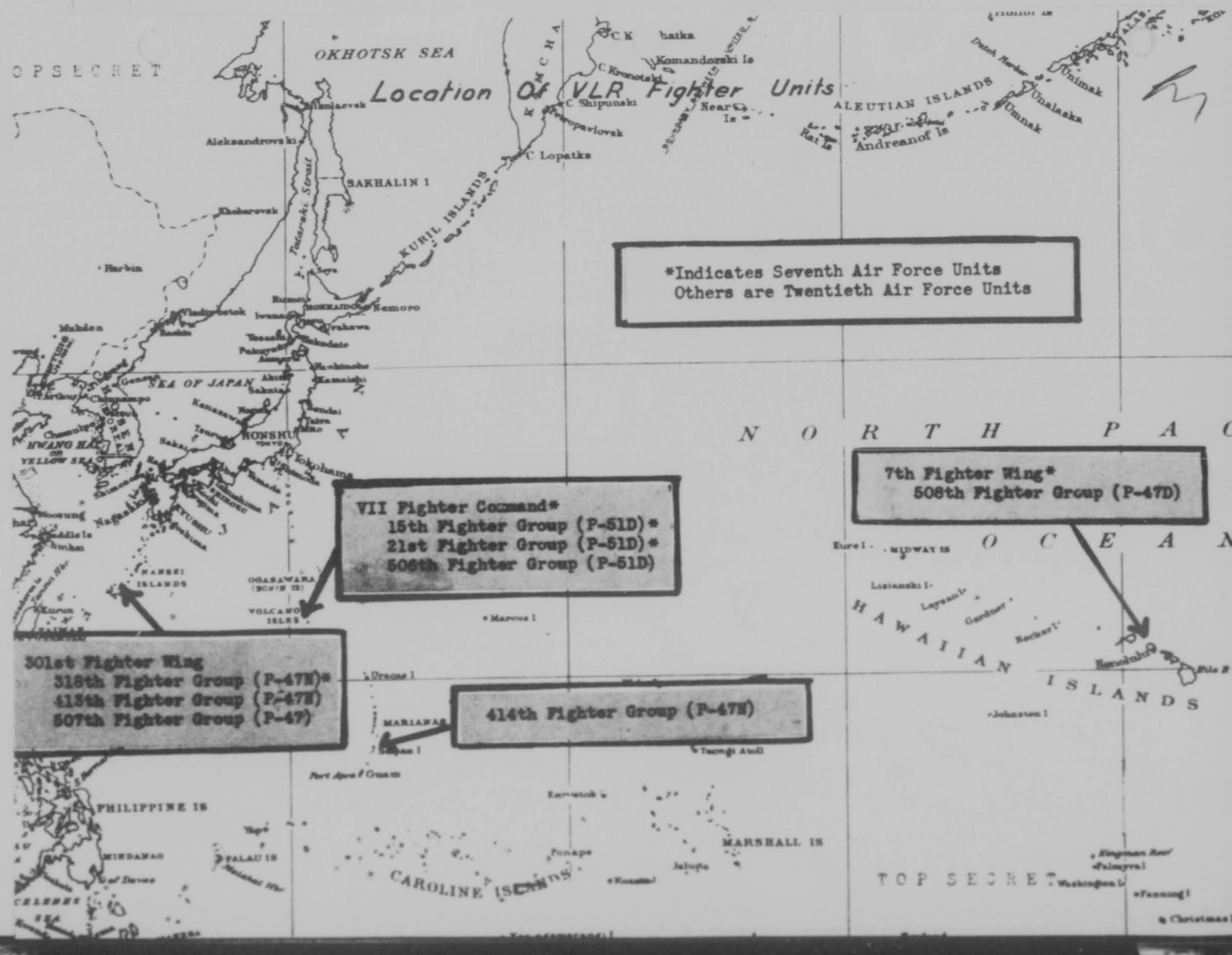


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COMPARISON OF P-47N AND P-51N AIRCRAFT

| | | Combat radius of action |
|---|---|---|
| P-47N | Internal fuel only | 575 miles |
| P-51H | Internal fuel only | 500 miles |
| P-47N | 2 - 165 gal tanks | 925 miles |
| P-51H | 2 - 110 gal tanks | 950 miles |
| P-47N | 2 - 165 gal tanks & 1 - 110 gal tank | 1075 miles |
| P-51H | 2 - 165 gal tanks | 1200 m iles |

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## SPECIFICATIONS AND REQUIREMENTS FOR VHB FIELDS

B-29 aircraft operating at 135,000 pounds or greater require the following field specifications:

I. Runways

(a) 8500' long
(b) 200' wide
(c) 150' shoulder width
(d) Support 70,000 pound wheel base load
(e) Glide angle 50' in 3 miles
(f) Maximum obstruction to takeoff - 150' at 15 miles
(g) Distance between parallel runways 1000' from center to center
(h) Maximum runway gradient (longitudinal) - 1.25%
(i) Maximum runway gradient (lateral)-1.50%

II. Hardstands

(1) Circular in design
(2) Paved radius of 60' with stabilized shoulders 10' wide
(3) Support 125% runway loading

III. Taxiways

(1) Cleared 230' wide
(2) Paved 80' wide with stabilized shoulders 110' wide
(3) Support 125% runway loading

IV. Housing and Location

(1) Airdrome area, which includes runways, taxiways, hardstands, and housing area, is 3000 acres.
(2) Optimum airdrome dimensions are 2 x 2.5 miles
(3) Minimum distance between circular airdromes is 10 miles
(4) Minimum distance between airdromes whose runways are in prolongation - 40 miles
(5) Minimum distance of runway convergence (prolonger paths) - 30 miles

V. Logistical Support

Logistical requirements of VLR fields make it imperative that location of site be near a port, railroad or large capacity road net. Gasoline consumption requires pipeline on port or rail center to tank farm and gravity flow from tank farm to the airdrome. Fastest and most economical fuel is direct from floating tanker to pipeline.

VI. Operational field experience has indicated that at shorter ranges to the target a runway 7500' can be employed for 132,000 pounds gross load.

NOTE: Design criteria specification in TM 5-225 Superbomber meets other requirements for VLR fields.

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STATISTICS ON B-29 FIELDS

(figures based on continental US Stations)

1. Length of Runways

   7000' MSL with 500' increase for every 1000' rise in elevation

2. Revetments

   150' center to center; hardstands 450' center to center. Oriented in different directions. All revetments not facing each other.

3. Taxi Strips

   75' with 12½' shoulders

4. Housing on B-29 Bases

   Information not available

5. Gasoline Storage Facilities

   500,000 gallons per group

NOTE: Buildings furnished in the continental United States, naturally, are different than those furnished for operational purposes in the theater, and it is suggested that a list of such facilities be obtained from the Air Engineer, Colonel Mayo (Col. Heiberg), Room 5 E 977, Extension 72907.

24 November 1944

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XXI BOMBER COMMAND

## AIR BASE FACILITIES

20 APRIL 1945

| ISLAND & FIELD | STRIP | RUNWAYS | | HARDSTANDS | | | | PARKING APRONS | | | AV. GAS STORAGE (IN 55's) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | STAGE OF COMPLETION | E.C.D. | PLANNED | STAGE OF COMPLETION | NUMBER USEABLE | E.C.D. | PLANNED SQ FT | STAGE OF COMPLETION | E.C.D. | PLANNED | STAGE OF COMPLETION | E.C.D. |
| GUAM — DEPOT FIELD | | COMPLETE | | 64 | COMPLETE | 64 | | 1,200,000<br>1,300,000 | COMPLETE<br>COMPLETE | | 27,000 | COMPLETE | |
| GUAM — NORTH FIELD | 1 | UNDER CONSTRUCTION | CORAL 1 MAY | 220 | 48 CORAL<br>71 ASPHALT COMPLETE | 103 | 90 - MAY | 600,000 | UNDER CONSTRUCTION | CORAL 1 MAY | 24,000 | COMPLETE | |
| | 2 | ASPHALT 50% COMPLETE 150' WIDE | | | | | | 600,000 | COMPLETE | | | | |
| GUAM — NORTHWEST FIELD | 1 | CLEARED | 1 JUL | 200 | NOT STARTED | | 90 - 1 JUN<br>200 - 1 JUL | 600,000 | BEING CLEARED | 1 JUN | 24,000 | NOT STARTED | 1 JUL |
| | 2 | UNDER CONSTRUCTION | 1 JUN | | | | | 600,000 | NOT STARTED | JUL | | | |
| TINIAN — NORTH FIELD | 1 | CORAL COMPLETE 50% PAVED | PAVED 1 OCT | 170 | 170 CORAL COMPLETE | 170 | | 780,000 | 2 GP APRONS PAVED<br>GP APRON FINISHED (CORAL)<br>GP APRON UNDER CONST | | 88,900 | 45,950 COMPLETE<br>RTU UNDER CONST | |
| | 2 | CORAL COMPLETE | 1 OCT | | | | | | | | | | |
| | 3 | CORAL COMPLETE | 1 OCT | | | | | | | | | | |
| | 4 | UNDER CONSTRUCTION | CONST HALTED | | | | | 780,000 | CORAL COMPLETE | | | | |
| TINIAN — WEST FIELD | 1 | CORAL COMPLETE | 1 OCT | 200 | 177 CORAL COMPLETE | 177 | 1 MAY | 780,000 | CORAL COMPLETE | | | | |
| | 2 | 50% CORAL COMPLETE | CORAL 1 MAY PAVED 1 OCT | | | | | 780,000 | NOT STARTED | CORAL 1 MAY | | | |
| SAIPAN — ISELY FIELD | 1 | COMPLETE | | 178 | COMPLETE | 178 | | 570,000 | COMPLETE | | 9,000 | COMPLETE | |
| | 2 | COMPLETE | | | | | | 600,000 | COMPLETE | | | | |
| IWO JIMA — CENTRAL FIELD | 4 | 1000 UNDER CONST | 1 JUN | 60 | NOT STARTED | | 5 - JUNE<br>40 - JULY | 2,000,000 * | UNDER CONST BEING USED FOR PARKING AREA | 1 JUN | 240,000<br>8,000 READY TANKS AT FIELD | 5% COMPLETE<br>ISLAND PIPELINE STARTED | NOV |
| | 5 | 5000' UNDER CONST | 1 JUN | | | | | 2,000,000 *<br>600,000 ** | UNDER CONSTRUCTION | JUL<br>JUN | | | |

GENERAL INFORMATION
- RUNWAYS -

WIDTH ——— 200 FEET
LENGTH ——— 8500 FEET EXCEPT DEPOT FIELD WHICH IS 7000 FT IN LENGTH
CONSTRUCTION CORAL BASE PAVED WITH ASPHALT

- NOTES -

ABOVE INFORMATION DOES NOT INCLUDE SUB SERVICE APRONS TO BE CONSTRUCTED AT NORTH FIELD TINIAN AND NORTH AND NORTHWEST FIELD GUAM
GRADE NO FACILITIES SHOWN ARE BULK STORAGE FOR ENTIRE ISLAND
E.C.D. - ESTIMATED COMPLETION DATE
* - REFUELING APRONS
** - SERVICE APRON

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## BOMB STATISTICS

Following aimable clusters will be used by B-29's and can be carried on 500# stations. Any mixed load of aimable incendiary clusters and 500# GP bombs can be carried. No information available on mixed loads of 1000# and 500# sizes.

| Cluster | Actual Wt. | Shipping Wt. | Volume |
|---|---|---|---|
| E46 (38x6# M69) | 421# | 575# | 11.2 cu ft. |
| E48 (38x10# M74) | 514# | | |
| M17A1 (110x4# M50) | 463# | 625# | 18.0 cu ft. |
| **Bombs** | | | |
| M76 (500#) | 455# | 475# | 10.1 cu ft. |
| M47A2 (100#) Carried 6 to a 500# sta. | 69# | 108# | 3.1 cu ft. |

### B-29 Bomb Stations

40 - 500# stations

12 - 1000# stations

8 - 2000# stations

The following computations are employed at the present time to procure bombs for the VLR program. Present bombing statistics from the XX and XXI Bomber Commands on the types of bombs dropped indicate that the percentages are exceedingly accurate.

| | Distribution of Tonnage in % |
|---|---|
| 2000 lb. . . . . | 1% |
| 1000 lb. . . . . | 9% |
| 500 lb. . . . . | 52% |
| 20 lb. Fragmentation, stabilized, clustered for 500 lb. stations | 5% |
| Incendiaries . . . . . | 33% |

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THIRTY DAY REQUIREMENTS TO SUPPORT A VLR WING

| Units | T/O | Date | Off | WO | EM | Total | Class I L/T | Class I MS/T | Class II L/T | Class II MS/T | Class III L/T | Class III MS/T | Class III-E (1) L/T | Class III-E (1) MS/T | Class IV (2) L/T | Class IV (2) MS/T | Class V L/T | Class V MS/T | Class V A/C Ammo L/T | Class V A/C Ammo MS/T | Total all Classes L/T | Total all Classes MS/T | Aviation Fuel Gallons | Aviation Fuel 42 gal bbls |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 - Bomb Sq, Hq & Hq Sq | 1-160-1 | | 86 | 2 | 136 | 224 | 19 | 28 | 9 | 28 | 25 | 41 | | - | 46 | 103 | 16 | 14 | | | 115 | 214 | | |
| 1 - Sig Co Sq | 11-247 | 1 Jul 42 | 7 | 0 | 119 | 126 | 10 | 16 | 5 | 16 | 14 | 23 | | | 26 | 58 | 9 | 8 | | | 64 | 121 | | |
| 4- Bomb Gp, Hq & Hq Sq VH | 1-112 | 29 Jun 44 | 30 | 1 | 74 | 420 | 35 | 52 | 17 | 53 | 46 | 77 | | | 87 | 193 | 29 | 26 | | | 214 | 401 | | |
| 12 - Bomb Sq VH | 1-167 | 17 Apr 44 | 122 | 0 | 527 | 7,788 | 649 | 969 | 324 | 985 | 861 | 1,435 | 622 | 651 | 1,613 | 3,585 | 539 | 488 | 2,458 | 3,120 | 7,066 | 11,233 | 5,400,000 | 128,571 |
| 4 - Service Gp, Hq & Base Service Sq | 1-452 T | 15 Apr 44 | 26 | 1 | 285 | 1,248 | 104 | 155 | 52 | 158 | 138 | 230 | | | 258 | 575 | 86 | 78 | | | 638 | 1,196 | | |
| 4 - Material Sq | 1-458 T | 15 Apr 44 | 7 | 1 | 132 | 560 | 47 | 70 | 23 | 71 | 62 | 103 | | | 116 | 258 | 39 | 35 | | | 287 | 537 | | |
| 4 - Engineering Sq | 1-457 T | 15 Apr 44 | 11 | 1 | 246 | 1,032 | 86 | 128 | 43 | 131 | 114 | 190 | | | 214 | 475 | 71 | 65 | | | 528 | 989 | | |
| 4 - Photo Lab Gp | 1-119 | 15 Jul 44 | 1 | 0 | 20 | 84 | 7 | 10 | 3 | 11 | 9 | 15 | | | 17 | 39 | 6 | 5 | | | 42 | 80 | | |
| 1 - Chemical Co, Air Operations | 3-457 | 13 Oct 44 | 4 | 0 | 130 | 134 | 11 | 17 | 6 | 17 | 15 | 25 | | | 28 | 62 | 9 | 8 | | | 69 | 129 | | |
| 1 - Air Depot Gp, Hq & Hq Sq | 1-852 | 20 Jan 44 | 25 | 0 | 165 | 190 | 16 | 24 | 8 | 24 | 21 | 35 | | | 39 | 87 | 13 | 12 | | | 97 | 182 | | |
| 1 - Depot Supply Sq | 1-858 | 25 Nov 43 | 7 | 0 | 124 | 131 | 11 | 16 | 5 | 17 | 14 | 24 | | | 27 | 60 | 9 | 8 | | | 66 | 125 | | |
| 1 - Depot Repair Sq | 1-857 | 15 Dec 43 | 13 | 0 | 356 | 369 | 31 | 46 | 15 | 47 | 41 | 68 | | | 76 | 170 | 26 | 23 | | | 189 | 354 | | |
| 1 - Med Supply Plat | 8-497 | 26 Jul 43 | 2 | 0 | 19 | 21 | 2 | 3 | 1 | 3 | 2 | 4 | | | 4 | 10 | 1 | 1 | | | 10 | 21 | | |
| 1 - QM Plat AD Gp | 10-427 | 17 Sep 43 | 2 | 0 | 22 | 24 | 2 | 3 | 1 | 3 | 3 | 4 | | | 5 | 11 | 2 | 2 | | | 13 | 23 | | |
| 2 - QM Trk Co, Avn | 10-517 | 18 Aug 43 | 3 | 0 | 99 | 204 | 17 | 25 | 8 | 26 | 23 | 38 | | | 42 | 94 | 14 | 13 | | | 104 | 196 | | |
| 1 - Sig Co Depot Avn | 11-287 | 11 Apr 44 | 9 | 1 | 179 | 189 | 16 | 24 | 8 | 24 | 21 | 35 | | | 39 | 87 | 13 | 12 | | | 97 | 182 | | |
| Engr Avn Bn, Sig Const Bn Avn & Theater Overhead | | | | | | 876 | 73 | 109 | 36 | 111 | 97 | 161 | | | 181 | 403 | 61 | 55 | | | 448 | 839 | | |
| Total | | | | | | 13,620 | 1,136 | 1,695 | 564 | 1,725 | 1 506 | 2,508 | 622 | 651 | 2,818 | 6,270 | 943 | 853 | 2,458 | 3,120 | 10,047 | 16,822 | 5,400,000 | 128,571 |

(1) Aviation oil & grease only.
(2) Includes Engr construction material.

Basis of Computation:

4 Bombing sorties per month per T/E Aircraft.
1 Non-bombing sortie per month per T/E Aircraft.
13 Hours non-operational flying per T/E Aircraft.
Aviation fuel consumption 300 gallons per hour.
Air Corps ammunition expenditure - Planning Factors, 1 May 1944 (Tab A)
Class I Supply .0833 L/T & .1244 MS/T per man per month overall average.
Class II Supply .04166 L/T & .12849 MS/T per man per month overall average.
Class III Supply .1106 L/T & .1843 MS/T per man per month overall average.
Class IV Supply .87905 L/T & .66036 MS/T per man per month overall average.
Class V Supply .04984 L/T & .0686 MS/T per man per month overall average.
MS/T - Measurement Ship Tons.
No allowance has been computed for stowage.

prepared by
Logistics Planning Branch
AC/AS, M & S
25 Oct 1944

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## LOGISTICAL TONNAGE OF SHIPPING

(required to transport the following units)

Here are figures in measurement tons based on Logistics Manual and information available in Logistics Planning Branch of Air Services Division. These figures include AAF and ASF Supplied OEL, TAT, and Vehicles, but do not include rations or maintenance.

| 9th Echelon | Measurement Tons |
|---|---|
| 345th Signal Co. Wing | 361 |
| 358th Service Group | 5826 |
| 359th Service Group | 5826 |
| Special List of Equipment | 130 |
| TOTAL | 12,143 |

| 10th Echelon | |
|---|---|
| Hq 313th Wing | 335 |
| 504th Bomb Gp. (Less 395rd Squadron) | 4122 |
| 505th Bomb Gp. | 6033 |
| 20th Photo Lab | 74* |
| 21st Photo Lab | 74* |
| TOTAL | 10,738 |

* plus Special list of Equipment 50

| 11th Echelon | |
|---|---|
| 6th Bomb Group | 6033 |
| 9th Bomb Group | 6033 |
| 22nd Photo Lab | 74 |
| 19th Photo Lab | 74 |
| 72nd Service Group | 5826 |
| 77th Service Group | 5826 |
| Special List of Equipment for Engineer Squadrons of Service Groups | 130 |
| | 23,996 |

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## LOW ALTITUDE

## ESTIMATED BOMB LOAD

The following is the estimated bomb load that a B-29 can carry operating at low altitude approach and bombing target from five to ten thousand feet altitude. Distances are radius of action.

(A) 1200 statute 1040 nautical 20,000 pounds
(B) 1300 statute 1130 nautical 20,000 pounds
(C) 1500 statute 1300 nautical 16,000 pounds
(D) 1600 statute 1380 nautical 12,000 pounds
(E) 1800 statute 1560 nautical 8,000 pounds

These estimates are based on use of 500 pound GP bomb. Loads with other types may be limited by bomb bay space in some cases, as per technical order 01-21 BJ-2.

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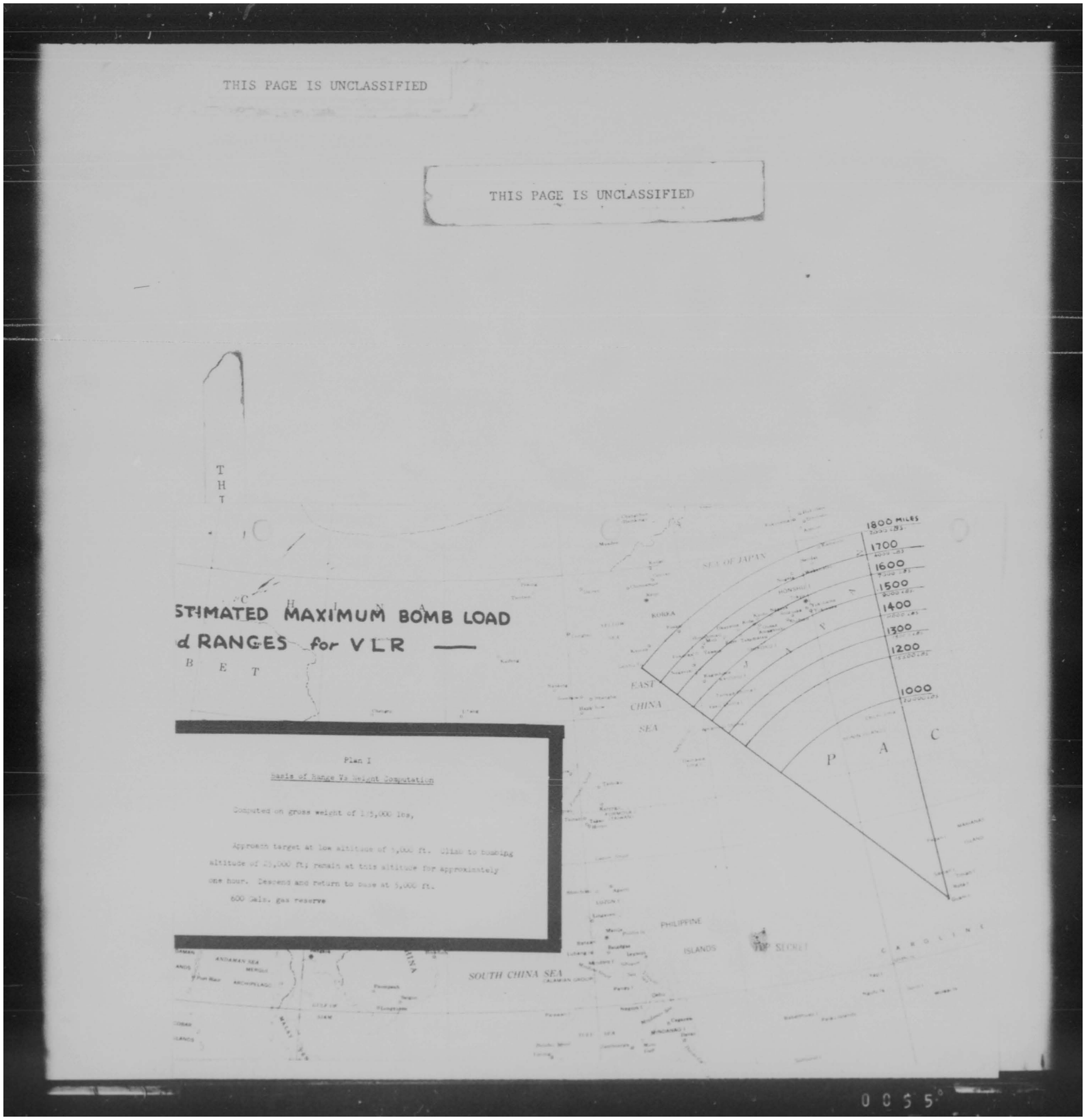




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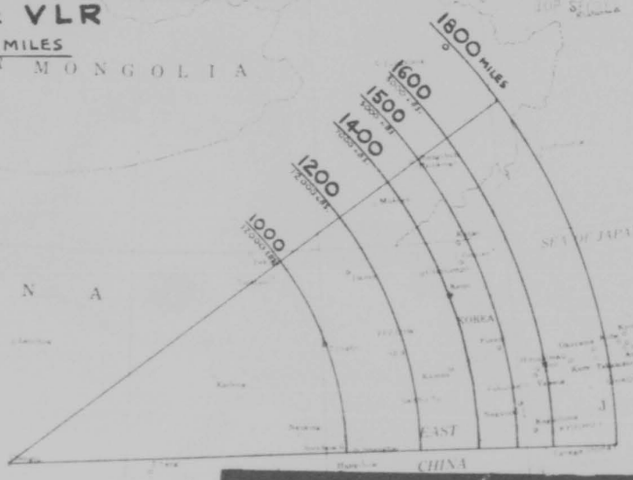
# ESTIMATED MAXIMUM BOMB LOAD AND RANGES FOR VLR

IN STATUTE MILES




Plan II

Basis of Range vs. Weight Computation

Chennolt Fields are limited to a gross weight take-off of [illegible] lbs.

Aircraft fly to the target and return at minimum altitude of 15,000 ft. over all enemy occupied territory. Bombing is accomplished from altitude of 25,000 ft.

[illegible] gallons of gas reserve.

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# ESTIMATED MAXIMUM BOMB LOAD and RANGES for VLR

IN STATUTE MILES

Plan III

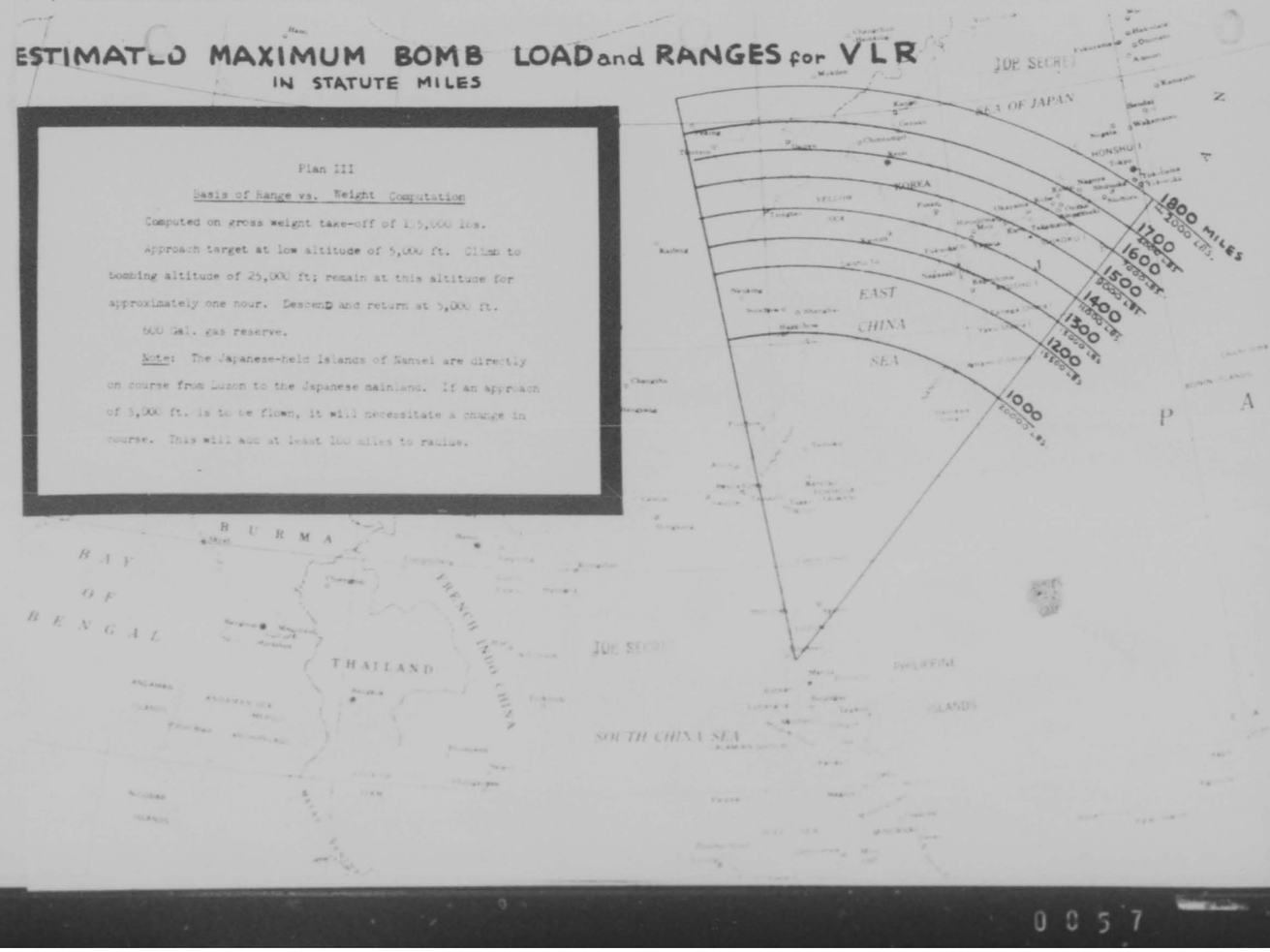
Basis of Range vs. Weight Computation

Computed on gross weight take-off of 135,000 lbs.

Approach target at low altitude of 5,000 ft. Climb to bombing altitude of 25,000 ft; remain at this altitude for approximately one hour. Descend and return at 5,000 ft.

600 Gal. gas reserve.

Note: The Japanese-held Islands of Nansei are directly on course from Luzon to the Japanese mainland. If an approach of 5,000 ft. is to be flown, it will necessitate a change in course. This will add at least 100 miles to radius.



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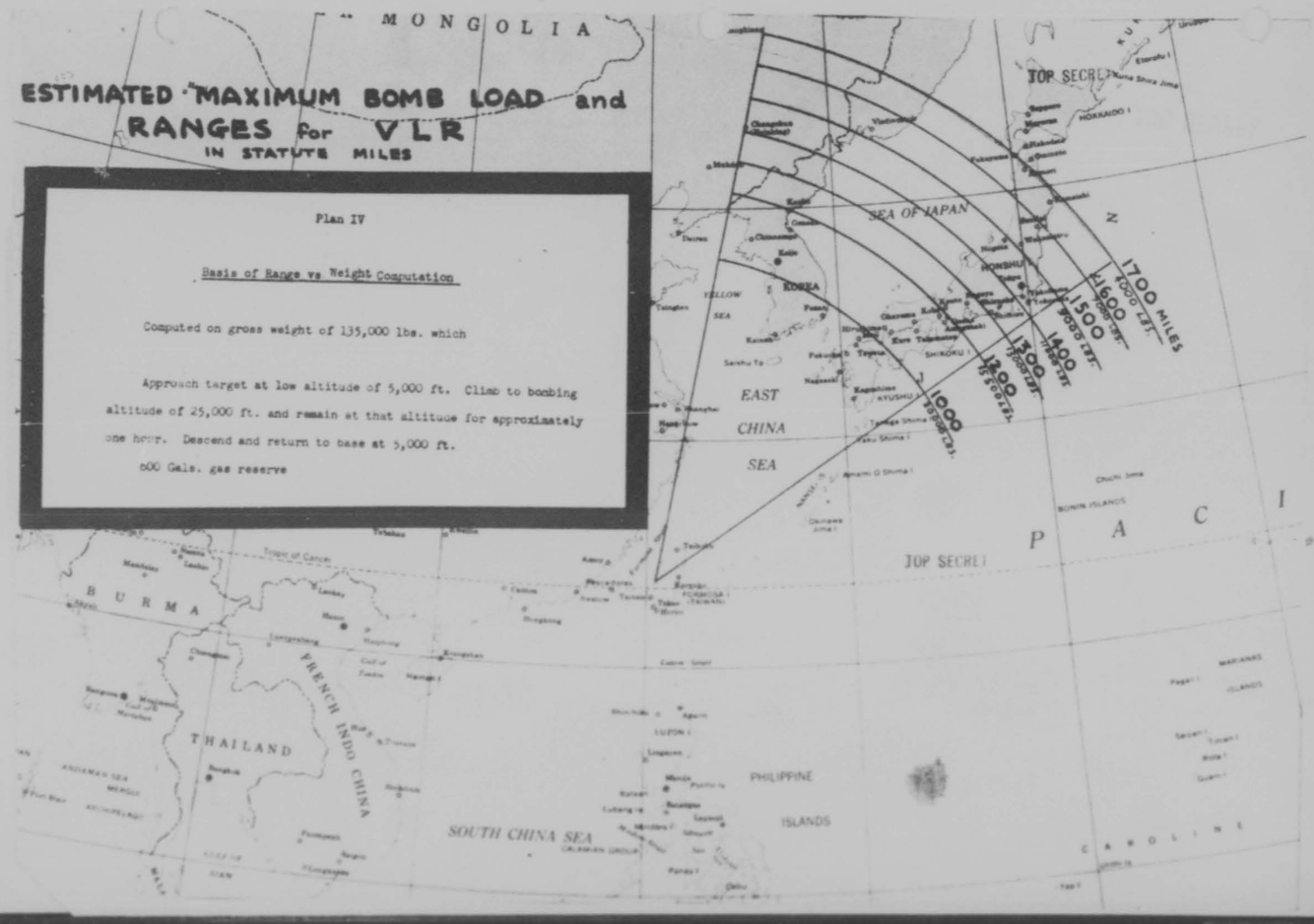




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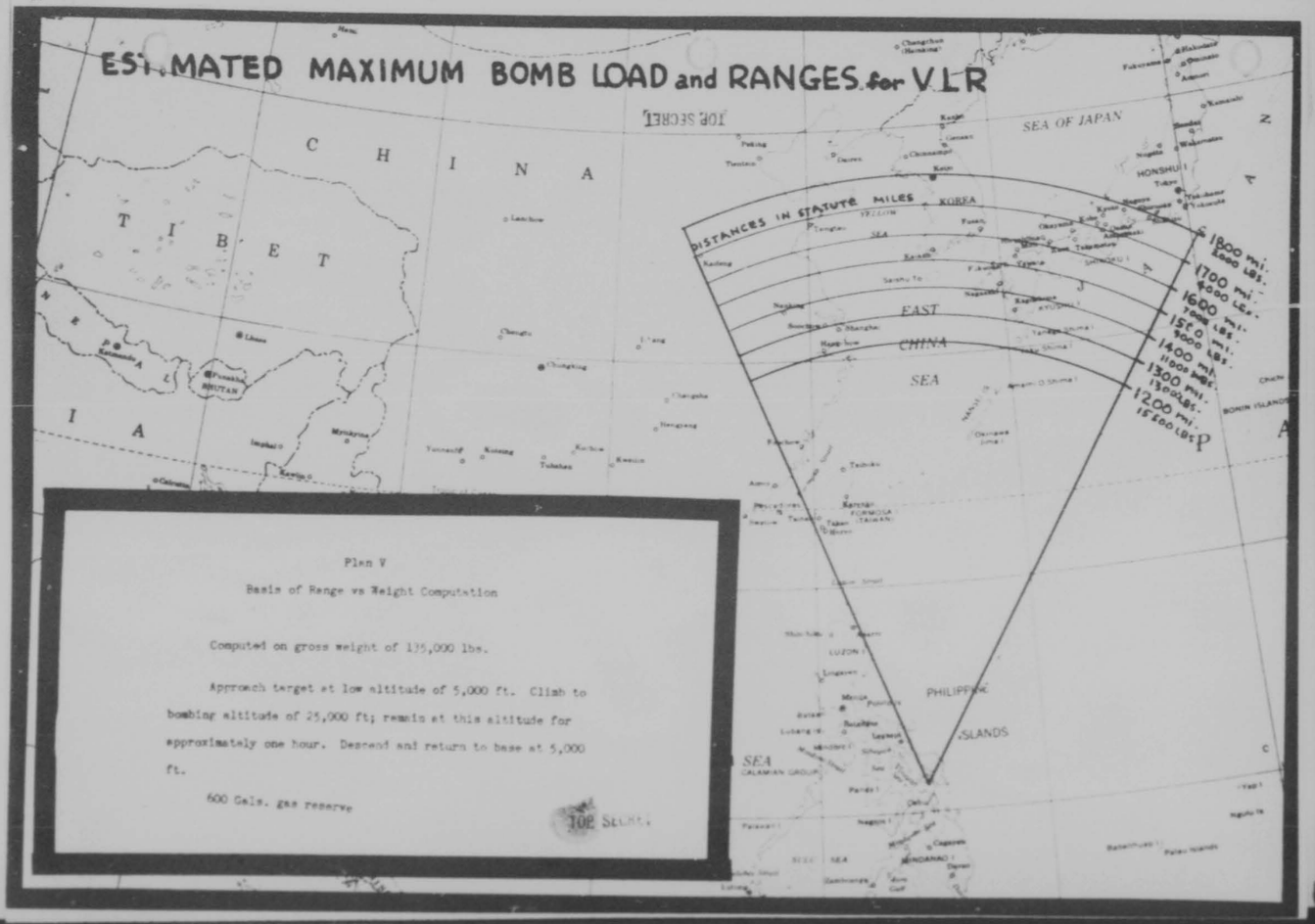


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# MONTHLY STATISTICAL SUMMARY

31 JUL 1945

PREPARED BY
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NOTE: The XXI Bomber Command was redesignated the Twentieth Air Force, 16 July 1945. Information contained herein includes only the operations of the XXI BC prior to 16 July and those of the 20th AF after that date. Activity of the 7th Fighter Command will be reflected in future reports.



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## STAFF PLANNING FACTORS



| | | 20 AF JULY PLAN | ACTUAL EXPERIENCE JULY | JUNE | MAY--JULY | 20 AF AUG PLAN |
|---|---|---|---|---|---|---|
| AIRCRAFT - | Average Assigned Strength | 894 | 923 | 791 | 808 | 953 |
| | Hours Flown Per Assigned Aircraft | 115 | 114 | 110 | 109 | 120 |
| | Total Sorties | 6350 | 6536 | 5633 | 5583# | 7100 |
| | Sorties Flown Per Assigned Aircraft | 7.1 | 7.1 | 7.1 | 6.9 | 7.5 |
| | Losses As A Percent Of Airborne | 1.5% | 0.8% | 0.8% | 1.4% | 1.2% |
| | War Weary Losses | 30 | 30 | 32 | 21# | 50 |
| | Total Losses | 96 | 55 | 79 | 76# | 88 |
| | Total Losses As A Percent Of U/E* | 16.1% | 8.9% | 15.0% | 14.1% | 13.9% |
| | Bomb Load Per A/C Airborne (Tons) | 7.25 | 7.7 | 6.7 | 7 | 8 |
| | Percent Of Aircraft Airborne That Bomb Prim Target | 94 | 94 | 90 | 92 | 94 |
| | Percent Of Aircraft Airborne That Bomb Any Target | 96 | 96 | 94 | 94 | 96 |
| CREWS - | Average Assigned Strength | 1124 | 1098 | 954 | 965 | 1312 |
| | Hours Flown Per Assigned Crew | 92 | 96 | 92 | 92 | 87 |
| | Sorties Flown Per Assigned Crew | 5.6 | 6.0 | 5.9 | 5.8 | 5.4 |
| | Losses As A Percent Of Airborne (Except Comp of Tour) | 1.2% | 0.5% | 0.5% | 0.9% | 0.5% |
| | Losses To Completion of Tour | 101 | 145 | 63 | 72# | 179 |
| | Total Losses | 177 | 175 | 104 | 121# | 217 |
| | Losses As A Percent of U/E* (Except Comp of Tour) | 12.8% | 4.9% | 7.8% | 9.1% | 6.0% |
| | Losses As A Percent of U/E* (Completion of Tour)** | 20.0% | 23.0% | 14.1% | 16.1% | 34.6% |

* U/E represents 2/3 of assigned A/C

** Adjusted to include only those wings eligible for rotation.

# Monthly average.

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| | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | CUM |
|---|---|---|---|---|---|---|---|---|---|---|
| Av B-29 A/C Asgd | 93.2 | 134.8 | 214.1 | 313.2 | 388.2 | 512.1 | 718.1 | 790.8 | 923.3 | - |
| Av B-29 Crews Asgd | 124.6 | 200.1 | 292.1 | 394.8 | 516.3 | 659.2 | 842.9 | 953.8 | 1038.0 | - |
| Sorties - Bombing | 303 | 526 | 567 | 861 | 2371 | 3286 | 3995 | 5030 | 5828 | 22767 |
| Mining | - | - | - | - | 200 | 57 | 421 | 367 | 384 | 1429 |
| Weather-Recon | - | 69 | 74 | 83 | 89 | 90 | 93 | 87 | 94 | 679 |
| Other | 1 | - | 7 | 34 | 58 | 57 | 72 | 149 | 230 | 608 |
| Total | 304 | 595 | 648 | 978 | 2718 | 3490 | 4581 | 5633 | 6536 | 25483 |
| Per A/C Asgd | 3.3 | 4.4 | 3.0 | 3.1 | 7.0 | 6.8 | 6.4 | 7.1 | 7.1 | - |
| Per Crew Asgd | 2.4 | 3.0 | 2.2 | 2.5 | 5.3 | 5.3 | 5.4 | 5.9 | 6.0 | - |
| Hours Flown - Per A/C Asgd - Combat | 34.8 | 50.0 | 36.8 | 42.1 | 101.2 | 95.5 | 90.6 | 99.4 | 99.5 | - |
| " " " - Total | 37.8 | 55.3 | 58.0 | 60.0 | 114.9 | 107.8 | 101.6 | 110.8 | 114.2 | - |
| Per Crew Asgd - Combat | 26.0 | 33.7 | 27.0 | 33.4 | 76.1 | 74.2 | 77.2 | 82.4 | 83.7 | - |
| " " " - Total | 28.3 | 37.3 | 42.5 | 47.6 | 86.4 | 83.8 | 86.6 | 91.9 | 96.0 | - |
| Tons of Bombs & Mines Dropped* | 448 | 1614 | 1012 | 1753 | 13744 | 16219 | 24491 | 32360 | 42519 | 134160 |
| Av Bomb Load (Tons) | 2.74 | 4.02 | 2.82 | 3.01 | 5.97 | 5.74 | 6.36 | 6.72 | 7.71 | - |
| % A/C Airborne Bombing Primary Targets* | 21.3 | 67.7 | 43.7 | 49.4 | 84.5 | 84.6 | 89.4 | 90.4 | 93.9 | - |
| % A/C Airborne Bombing Any Target* | 79.2 | 82.9 | 81.9 | 87.3 | 93.1 | 93.1 | 92.5 | 93.9 | 95.5 | - |
| # Days On Which Missions Were Conducted | 3 | 7 | 6 | 5 | 10 | 19 | 20 | 17 | 19 | 106 |

OPERATIONS

NOTE: 55% of all weather-recon missions have been flown by 73rd Wg. All mining missions have been flown by the 313th Wg.
"A/C Asgd" excludes A/C in Depot. "Asgd" crews exclude those in U.S. for lead crew training.

* Based on bombing & mining missions to Japan only.



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## SUMMARY OF WING PERFORMANCE



| | 58TH WG | | 73RD WG | | 313TH WG | | 314TH WG | | [illegible] WG | | 6[illegible] | | 3RD PRS[a] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUN | JUL | JUN | JUL | JUN | JUL | JUN | JUL | [illegible] | [illegible] | [illegible] | [illegible] | JUN | JUL |
| Av B-29 A/C Asgd | 171.7 | 189.9 | 187.2 | 194.6 | 180.8 | 190.8 | 183.4 | 192.8 | [illegible] | [illegible] | [illegible] | [illegible] | 15 | 18.7 |
| Av B-29 Crews Asgd | 217.5 | 232.2 | 230.5 | 233.1 | 221.0 | 243.8 | 222.0 | 236.1 | 54.5 | 130.6 | [illegible] | 9.3 | 27 | 28.7 |
| Sorties - Bombing | 1303 | 1288 | 1392 | 1390 | 979 | 1090 | 1285 | 1368 | 71 | 634 | - | - | - | - |
| Other | 14 | 9 | 59 | 61 | 424 | 430 | 59 | 92 | 16 | 11 | 31 | 105 | 55 | 63 |
| Total | 1317 | 1297 | 1451 | 1451 | 1403 | 1520 | 1344 | 1480 | 87 | 645 | 31 | 105 | 55 | 63 |
| Per A/C Asgd | 7.7 | 6.8 | 7.8 | 7.5 | 7.8 | 8.0 | 7.3 | 7.7 | 1.5 | 4.9 | 9.7 | 10.3 | 3.7 | 3.6 |
| Per Crew Asgd | 6.1 | 5.6 | 6.3 | 6.2 | 6.3 | 6.2 | 6.1 | 6.3 | 1.6 | 4.9 | 9.7 | 11.3 | 2.0 | 2.2 |
| Hours Flown - | | | | | | | | | | | | | | |
| Per A/C Asgd - Combat | 109.4 | 100.7 | 106.3 | 104.7 | 107.6 | 108.7 | 103.9 | 109.5 | 19.6 | 68.2 | 67.8 | 81.1 | 43.5 | 53.5 |
| " " " - Total | 121.2 | 116.4 | 116.9 | 121.6 | 116.6 | 122.6 | 111.9 | 120.2 | 45.9 | 85.2 | 67.8 | 81.1 | 46.6 | 54.6 |
| Per Crew Asgd - Combat | 86.4 | 82.4 | 86.3 | 87.4 | 88.0 | 85.1 | 85.9 | 89.4 | 21.2 | 69.0 | 67.8 | 83.9 | 24.2 | 31.1 |
| " " " - Total | 95.7 | 95.2 | 95.0 | 101.5 | 97.0 | 96.0 | 92.5 | 98.2 | 49.7 | 86.2 | 67.8 | 83.9 | 25.9 | 31.7 |
| Tons of Bombs & Mines Dropped[b] | 7734 | 8922 | 8855 | 9359 | 8124 | 9889 | 7209 | 9404 | 438 | 4945 | - | - | - | - |
| Av Bomb Load (Tons)[b] | 6.55 | 7.69 | 6.95 | 7.41 | 6.75 | 7.77 | 6.64 | 7.43 | 7.32 | 8.91 | - | - | - | - |
| % A/C Airbn Bomb'g Prim Targets[b] | 90.9 | 93.6 | 92.2 | 94.9 | 90.1 | 93.0 | 88.3 | 94.6 | 91.5 | 92.8 | - | - | 40.0[c] | 58.7[c] |
| % A/C Airbn Bomb'g Any Target[b] | 94.8 | 95.4 | 94.2 | 96.3 | 94.3 | 95.1 | 92.4 | 95.5 | 93.0 | 94.9 | - | - | 41.8[d] | 22.2[d] |
| Number of Mission-Days | 11 | 9 | 10 | 10 | 16 | 17 | 10 | 10 | 2 | 9 | - | - | - | - |

NOTE: "A/C Asgd" excludes A/C in Depot. "Asgd" crews exclude those in U.S. for lead crew training.

a Applies to F-13 A/C only.

b Based on bombing & mining missions to Japan only.

c % of airborne obtaining good to excellent results.

d % of airborne obtaining poor to fair results.

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# SUMMARY OF ABORTING AIRCRAFT

– For Bombing & Mining Missions to Japan Only–



| | 58TH WG | | | 73RD WG | | | 313TH WG | | | 314TH WG | | | 315TH WG | | 20TH AF | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | MAY | JUN | JUL | MAY | JUN | JUL | MAY | JUN | JUL | JUN | JUL | MAY | JUN | JUL |
| Mech Failure – Engines | 24 | 36 | 38 | 37 | 46 | 32 | 39 | 41 | 36 | 41 | 51 | 36 | 4 | 12 | 141 | 178 | 154 |
| Mech Failure – Other | 10 | 15 | 10 | 25 | 12 | 10 | 26 | 15 | 18 | 19 | 17 | 14 | – | 11 | 80 | 59 | 63 |
| Pers'l Failure – Ground Crew | 16 | 6 | 5 | 15 | 16 | 6 | 20 | 13 | 15 | 10 | 15 | 7 | – | 1 | 61 | 50 | 34 |
| Pers'l Failure – Air Crew | 5 | 6 | 4 | 6 | 7 | 2 | 9 | 5 | 2 | 15 | 8 | 2 | – | 4 | 35 | 26 | 15 |
| Flight Conditions | – | 1 | – | 1 | – | – | 1 | – | – | – | – | – | – | – | 2 | 1 | – |
| Unknown and Other | 5 | 3 | 1 | 5 | – | – | 2 | 1 | 2 | 3 | 5 | 2 | 1 | 4 | 15 | 10 | 9 |
| TOTAL | 60 | 67 | 58 | 89 | 81 | 50 | 97 | 75 | 73 | 88 | 96 | 61 | 5 | 32 | 334 | 324 | 275 |
| A/C AIRBORNE | 916 | 1303 | 1288 | 1155 | 1392 | 1390 | 1163 | 1346 | 1474 | 1182 | 1285 | 1388 | 71 | 634 | 4416 | 5397 | 6212 |
| FAILURES AS A % OF AIRBN: | | | | | | | | | | | | | | | | | |
| Mech Failure – Engines | 2.7 | 2.8 | 3.0 | 3.2 | 3.3 | 2.3 | 3.4 | 3.0 | 2.4 | 3.5 | 4.0 | 2.6 | 5.6 | 1.9 | 3.2 | 3.3 | 2.5 |
| Mech Failure – Other | 1.1 | 1.2 | .8 | 2.2 | .9 | .7 | 2.2 | 1.1 | 1.2 | 1.6 | 1.3 | 1.0 | – | 1.7 | 1.8 | 1.1 | 1.0 |
| Pers'l Failure – Ground Crew | 1.7 | .5 | .4 | 1.3 | 1.1 | .4 | 1.7 | 1.0 | 1.0 | .8 | 1.2 | .5 | – | .2 | 1.4 | .9 | .6 |
| Pers'l Failure – Air Crew | .5 | .5 | .3 | .5 | .5 | .1 | .8 | .4 | .1 | 1.3 | .6 | .1 | – | .6 | .8 | .5 | .2 |
| Flight Conditions | – | .1 | – | .1 | – | – | .1 | – | – | – | – | – | – | – | – | – | – |
| Unknown and Other | .5 | .2 | .1 | .4 | – | – | .2 | .1 | .1 | .3 | .4 | .1 | 1.4 | .6 | .3 | .2 | .1 |
| TOTAL | 6.6 | 5.1 | 4.5 | 7.7 | 5.6 | 3.4 | 8.3 | 5.6 | 4.9 | 7.4 | 7.5 | 4.4 | 7.0 | 5.1 | 7.6 | 6.0 | 4.4 |

This breakdown lists all failures to carry out primary purpose of auxiliary A/C, as well as those failing to bomb.

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## TONNAGE & TARGET DAMAGE SUMMARY



| TARGET | TONS OF BOMBS DROPPED | | | | NUMBER A/C BOMBING | | | | TARGET DAMAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | TO DATE | MAY | JUN | JUL | TO DATE | JUL | TO DATE |
| URBAN AREAS | | | | | | | | | | |
| Akashi | - | - | 975.0 | 975.0 | - | - | 123 | 123 | .90 sq mi | .90 sq mi |
| Aomori | - | - | 546.5 | 551.5 | - | - | 61 | 63 | unavailable | unavailable |
| Chiba | - | - | 889.5 | 892.3 | - | - | 124 | 125 | .86 sq mi | .86 sq mi |
| Choshi | - | - | 704.8 | 752.8 | - | - | 91 | 100 | .48 sq mi | .48 sq mi |
| Fukui | - | - | 953.4 | 953.4 | - | - | 127 | 127 | 1.61 sq mi | 1.61 sq mi |
| Fukuoka | - | 1525.0 | - | 1525.0 | - | 221 | - | 221 | - | 1.37 sq mi |
| Gifu | - | - | 898.8 | 898.8 | - | - | 129 | 129 | 1.93 sq mi | 1.93 sq mi |
| Hamamatsu | 1521.5 | 956.2 | 7.5 | 3068.8 | 278 | 142 | 3 | 559 | - | 2.97 sq mi |
| Himeji | - | - | 767.1 | 767.1 | - | - | 106 | 106 | 1.48 sq mi | 1.48 sq mi |
| Hiratsuka | - | - | 1162.5 | 1162.5 | - | - | 133 | 133 | 1.04 sq mi | 1.04 sq mi |
| Hitachi | - | - | 971.2 | 971.2 | - | - | 128 | 128 | .88 sq mi* | 1.08 sq mi* |
| Ichinomiya | - | - | 1640.8 | 1640.8 | - | - | 247 | 247 | .97 sq mi* | .97 sq mi* |
| Imabari | 76.5 | - | - | 76.5 | 12 | - | - | 12 | unknown | unknown |
| Kagoshima | 3.0 | 811.6 | - | 1023.1 | 1 | 118 | - | 171 | - | 2.15 sq mi |
| Kawasaki | 6.0 | - | - | 1515.0 | 1 | - | - | 250 | - | 3.70 sq mi |
| Kobe | 5.5 | 3084.8 | - | 5647.8 | 2 | 477 | - | 874 | - | 8.75 sq mi |
| Kochi | - | - | 1082.1 | 1117.6 | - | 4 | 128 | 134 | .92 sq mi | .92 sq mi |
| Kofu | - | - | 970.4 | 977.9 | 1 | - | 131 | 133 | 1.30 sq mi | 1.30 sq mi |

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| TARGET | TONS OF BOMBS DROPPED | | | | NUMBER A/C DISPATCHED | | | | TARGET DAMAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | TO DATE | MAY | JUN | JUL | TO DATE | JUL | TO DATE |
| URBAN AREAS (Cont) | | | | | | | | | | |
| Kumamoto | - | - | 1121.2 | 1121.2 | - | - | 155 | 155 | 1.00 sq mi | 1.00 sq mi |
| Kure | 9.5 | - | 1081.7 | 1093.7 | 4 | - | 152 | 157 | 1.50 sq mi* | 1.50 sq mi* |
| Kuwana | - | - | 1511.3 | 1511.3 | - | - | 217 | 217 | .63 sq mi | .63 sq mi |
| Matsuyama | - | - | 896.0 | 896.0 | - | - | 128 | 128 | 1.22 sq mi* | 1.22 sq mi* |
| Miyakanojo | 158.0 | - | - | 158.0 | 27 | - | - | 27 | unknown | unknown |
| Moji | - | 625.9 | - | 626.9 | - | 91 | - | 92 | - | .30 sq mi |
| Nagoya | 6132.1 | - | 5.0 | 10136.8 | 932 | - | 1 | 1646 | - | 12.37 sq mi |
| Nobeoka | 5.0 | 837.7 | 16.0 | 859.9 | 1 | 119 | 2 | 123 | - | .52 sq mi |
| Numazu | - | - | 1035.8 | 1051.7 | - | - | 119 | 125 | 1.25 sq mi | 1.25 sq mi |
| Ogaki | - | - | 663.7 | 663.7 | - | - | 93 | 93 | .54 sq Mi* | .54 sq mi* |
| Oita | 3.5 | - | 798.4 | 801.9 | 3 | - | 128 | 131 | .56 sq mi | .56 sq mi |
| Okayama | - | 981.5 | - | 985.5 | - | 138 | - | 140 | - | 2.13 sq mi |
| Okazaki | - | - | 850.0 | 857.4 | - | - | 126 | 128 | .65 sq mi | .65 sq mi |
| Omuta | - | 769.2 | 964.6 | 1733.8 | - | 116 | 124 | 240 | unavailable | .22 sq mi |
| Osaka-Anagasaki | 8.0 | 8537.6 | 64.7 | 10417.3 | 1 | 1312 | 9 | 1627 | - | 16.44 sq mi |
| Sakai | - | - | 778.9 | 778.9 | - | - | 116 | 116 | .99 sq mi* | .99 sq mi* |
| Sasebo | 3.0 | 1058.9 | - | 1070.9 | 1 | 141 | - | 145 | - | .41 sq mi* |
| Sendai | - | - | 922.4 | 932.3 | - | - | 126 | 129 | 1.22 sq mi | 1.22 sq mi |
| Shimizu | - | - | 1067.8 | 1101.9 | - | 1 | 139 | 151 | .74 sq mi | .74 sq mi |



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## TONNAGE & TARGET DAMAGE SUMMARY (CONT)



| TARGET | TONS OF BOMBS DROPPED | | | | NUMBER A/C BOMBING | | | | TARGET DAMAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | TO DATE | MAY | JUN | JUL | TO DATE | JUL | TO DATE |
| URBAN AREAS (Cont) | | | | | | | | | | |
| Shimonoseki | - | 1.0 | 833.0 | 836.4 | - | 1 | 128 | 130 | .51 sq mi | .51 sq mi |
| Shizuoka | 48.6 | 868.3 | - | 1013.3 | 8 | 123 | - | 157 | - | 2.28 sq mi |
| Takamatsu | - | - | 833.1 | 833.1 | - | - | 116 | 116 | 1.44 sq mi | 1.44 sq mi |
| Tokushima | - | 71.1 | 1056.8 | 1127.9 | - | 11 | 130 | 141 | 1.70 sq mi | 1.70 sq mi |
| Tokuyama | 35.5 | - | 751.5 | 789.5 | 8 | - | 98 | 107 | unavailable | - |
| Tokyo | 6983.3 | - | 5.0 | 13684.1 | 998 | - | 1 | 2452 | - | 56.30 sq mi |
| Toyohashi | 9.0 | 959.9 | - | 1026.1 | 2 | 137 | - | 160 | - | 1.70 sq mi |
| Tsu | 5.0 | 190.2 | 1308.1 | 1507.3 | 1 | 31 | 189 | 222 | 1.05 sq mi* | 1.05 sq mi* |
| Tsuruga | - | 7.0 | 685.2 | 692.2 | - | 1 | 93 | 94 | .77 sq mi* | .77 sq mi* |
| Ube | - | - | 722.2 | 726.7 | - | - | 101 | 103 | .42 sq mi | .42 sq mi |
| Utsonomiya | - | - | 802.9 | 802.9 | - | - | 115 | 115 | .88 sq mi* | .88 sq mi* |
| Ujiyamada | 6.0 | 38.1 | 742.6 | 832.3 | 1 | 7 | 94 | 118 | .36 sq mi* | .36 sq mi* |
| Uwajima | 8.2 | 20.3 | 1077.8 | 1106.3 | 2 | 4 | 153 | 159 | .14 sq mi | .14 sq mi |
| Wakayama | - | 45.7 | 815.3 | 878.8 | - | 7 | 110 | 124 | 2.19 sq mi | 2.19 sq mi |
| Yokkaichi | - | 585.6 | - | 591.6 | - | 92 | - | 95 | - | 1.23 sq mi |
| Yokohama | 2569.6 | - | - | 2590.8 | 454 | - | - | 463 | - | 8.90 sq mi |
| Other | 396.8 | 543.2 | 383.8 | 2020.6 | 112 | 97 | 59 | 433 | - | - |
| TOTAL | 17993.6 | 22509.8 | 33364.4 | 92376.1 | 2850 | 3391 | 4553 | 14394 | 32.13 sq mi | 154.07 sq mi |

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## TONNAGE & TARGET DAMAGE SUMMARY (CONT)



| TARGET | TONS OF BOMBS DROPPED | | | | NUMBER A/C BOMBING | | | | TARGET DAMAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | TO DATE | MAY | JUN | JUL | TO DATE | JUL | TO DATE |
| AIRCRAFT INDUSTRIES | | | | | | | | | | |
| Aichi A/C Co, Eitoku | - | 353.0 | 451.0 | 817.8 | - | 51 | 66 | 124 | 417,200 sq ft* | 985,560 sq ft* |
| Aichi Ord. Plant, Nagoya | - | 271.0 | - | 271.0 | - | 42 | - | 42 | - | 1,130,800 sq ft |
| Hiro Naval Fty, Kure | 581.0 | - | - | 581.0 | 149 | - | - | 149 | - | 779,457 sq ft |
| Hitachi A/C Co, Chiba | - | 144.2 | - | 144.2 | - | 27 | - | 27 | - | none |
| Hitachi A/C Eng Co, Tachikawa | - | - | - | 473.5 | - | - | - | 101 | - | 836,626 sq ft |
| Japan A/C Co, Tomioka | - | 172.5 | - | 172.5 | - | 32 | - | 32 | - | 247,900 sq ft |
| Kawanishi A/C Co, Fukae | 459.5 | - | - | 459.5 | 92 | - | - | 92 | - | 504,247 sq ft |
| Kawanishi A/C Co, Himeji | - | 350.7 | - | 350.7 | - | 52 | - | 52 | - | 948,650 sq ft |
| Kawanishi A/C Co, Naruo | - | 263.5 | - | 263.5 | - | 44 | - | 44 | - | 1,807,250 sq ft |
| Kawanishi A/C Co, Takarazuka | - | - | 457.5 | 457.5 | - | - | 78 | 78 | 1,438,800 sq ft | 1,438,800 sq ft |
| Kawasaki A/C Co, Akashi | 2.2 | 483.0 | - | 637.7 | 1 | 81 | - | 144 | - | 2,511,450 sq ft |
| Kawasaki A/C Co, Kagamigahara | - | 232.0 | - | 232.0 | - | 40 | - | 40 | - | 953,700 sq ft |
| Mitsubishi A/C Co, Kagamigahara | - | 508.5 | - | 508.5 | - | 78 | - | 78 | - | 227,000 sq ft |
| Mitsubishi A/C Co, Nagoya | - | - | - | 251.6 | - | - | - | 104 | - | 3,880,795 sq ft |
| Mitsubishi A/C Co, Tamashima | - | 602.6 | - | 610.8 | - | 108 | - | 111 | - | 2,655,650 sq ft |
| Mitsubishi A/C Eng Co, Nagoya | - | - | - | 2668.5 | - | - | - | 570 | - | 3,584,100 sq ft |
| Nakajima A/C Co, Handa | - | - | 544.3 | 544.3 | - | - | 78 | 78 | 667,500 sq ft* | 667,500 sq ft* |
| Nakajima A/C Co, Koizumi | - | - | - | 274.7 | - | - | - | 46 | - | 662,900 sq ft* |
| Nakajima A/C Co, Musashino | 3.0 | - | 5.0 | 2363.5 | 1 | - | 1 | 454 | - | 1,746,500 sq ft |





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## TONNAGE & TARGET DAMAGE SUMMARY (CONT)



| TARGET | TONS OF BOMBS DROPPED | | | | NUMBER A/C BOMBING | | | | TARGET DAMAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | TO DATE | MAY | JUN | JUL | TO DATE | JUL | TO DATE |
| AIRCRAFT INDUSTRIES (Cont) | | | | | | | | | | |
| Nakajima A/C Co, Ogikubu | - | 38.0 | - | 38.0 | - | 7 | - | 7 | unknown | unknown |
| Nakajima A/C Co, Ota | - | - | - | 245.5 | - | - | - | 87 | - | 1,699,450 sq ft |
| Omura A/C Factory, Omura | - | - | - | 87.5 | - | - | - | 39 | - | 544,025 sq ft |
| Shizuoka A/C Eng Co, Shizuoka | - | - | - | 237.2 | - | - | - | 59 | - | 823,100 sq ft |
| Tachikawa A/C Co, Tachikawa | - | - | - | 549.6 | - | - | - | 73 | - | 807,000 sq ft |
| Tachikawa Air Depot, Tachikawa | - | 168.5 | - | 197.5 | - | 30 | - | 37 | - | 1,623,400 sq ft |
| Tachiarai Machine Works | - | - | - | 416.7 | - | - | - | 105 | - | 459,000 sq ft |
| Other | - | 11.0 | - | 58.4 | - | 2 | - | 12 | - | - |
| TOTAL | 1045.7 | 3596.7 | 1457.8 | 13913.2 | 243 | 594 | 223 | 2787 | 2,573,500 sq ft | 31,794,860 sq ft |
| OIL & FUEL INDUSTRIES | | | | | | | | | | |
| Hayama & Mitsubishi Refineries | - | - | 650.0 | 650.0 | - | - | 75 | 75 | 756,100 bbls* | 756,100 bbls* |
| Kawasaki Petroleum Center | - | - | 452.0 | 452.0 | - | - | 53 | 53 | 61,400 bbls* | 61,400 bbls* |
| Maruzen Oil Refinery, Minoshima | - | - | 738.2 | 738.2 | - | - | 98 | 98 | 900,000 bbls | 900,000 bbls |
| Nippon Oil Co, Anagasaki | - | - | 684.8 | 684.8 | - | - | 83 | 83 | 567,300 bbls | 710,700 bbls |
| Nippon Oil Co, Kudomatsu | - | 208.5 | 493.8 | 702.3 | - | 32 | 61 | 93 | unavailable | unavailable |
| Oshima Oil Storage | 383.2 | - | - | 385.7 | 80 | - | - | 81 | - | 45,000 sq ft |
| Otake Oil Refinery, Otake | 564.2 | - | - | 564.2 | 115 | - | - | 115 | unavailable | unavailable |
| Shimotsu Oil Refinery, Wakayama | - | - | 675.3 | 675.3 | - | - | 80 | 80 | unavailable | unavailable |
| Tokuyama Synthetic Oil Plant | 275.0 | - | - | 275.0 | 60 | - | - | 60 | included with Tokuyama Fueling Sta. | |
| Tokuyama Navy Fuel Station | 231.8 | - | - | 231.8 | 52 | - | - | 52 | - | 565,150 sq ft |





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## TONNAGE & TARGET DAMAGE SUMMARY (CONT)



| TARGET | TONS OF BOMBS DROPPED | | | | NUMBER A/C BOMBING | | | | TARGET DAMAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MAY | JUN | JUL | TO DATE | MAY | JUN | JUL | TO DATE | JUL | TO DATE |
| OIL & FUEL INDUSTRIES (Cont) | | | | | | | | | | |
| The Coal Liquefaction Co | - | - | 636.8 | 636.8 | - | - | 74 | 74 | unavailable | - |
| Itsube Oil Refinery, Yokkaichi | - | 256.8 | 468.7 | 725.5 | - | 39 | 61 | 100 | 84,240 bbls | 946,940 bbls |
| Other | - | - | 10.0 | 38.8 | - | - | 2 | 11 | - | - |
| TOTAL | 1454.2 | 465.3 | 4809.6 | 6760.4 | 307 | 71 | 587 | 975 | - | - |
| OTHER INDUSTRIES & TARGETS | | | | | | | | | | |
| Atsuta Fty, Nagoya Arsenal | - | 94.8 | - | 115.4 | - | 16 | - | 23 | - | 1,353,485 sq ft |
| Chigusa Arsenal, Nagoya | - | 189.0 | - | 189.0 | - | 33 | - | 33 | - | 1,226,060 sq ft* |
| Hitachi Engrg Wks, Kaigan | - | 806.0 | - | 806.0 | - | 118 | - | 118 | - | 2,142,900 sq ft |
| Hodagaya Chemical, Koriyama | - | - | - | 283.7 | - | - | - | 71 | - | 457,900 sq ft |
| Koriyama Chemical, Koriyama | - | - | - | 171.7 | - | - | - | 70 | - | 555,000 sq ft |
| Kure Naval Arsenal | - | 795.8 | - | 795.8 | - | 162 | - | 162 | - | 2,879,510 sq ft |
| Osaka Army Arsenal | - | 758.0 | 216.0 | 978.5 | - | 109 | 35 | 145 | 513,500 sq ft | 989,800 sq ft |
| Sumitomo Duraluminum Co, Nagoya | - | 150.0 | - | 150.0 | - | 29 | - | 29 | - | 1,339,900 sq ft |
| Sumitomo Light Metal, Osaka | - | 382.0 | 494.0 | 876.0 | - | 64 | 83 | 147 | 1,696,025 sq ft | 2,105,725 sq ft |
| Other | 9.5 | 11.0 | 126.8 | 193.3 | 14 | 4 | 24 | 45 | - | - |
| TOTAL | 9.5 | 3186.6 | 836.8 | 4557.4 | 14 | 535 | 142 | 843 | 2,209,525 sq ft | 13,052,280 sq ft |
| AIRFIELDS & SEAPLANE BASES | 1615.4 | 440.6 | 36.6 | 8452.7 | 305 | 80 | 6 | 1764 | - | - |
| ISLAND TARGETS | 70.5 | 96.5 | 19.0 | 2511.8 | 9 | 17 | 4 | 494 | - | - |
| MINE FIELDS | 2406.0 | 2081.0 | 2185.0 | 8008.0 | 375 | 326 | 331 | 1258 | - | - |
| TOTAL | 24594.9 | 32378.5 | 42711.2 | 136579.6 | 4103 | 5014 | 5846 | 22515 | - | - |

*Preliminary Data





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## AIR FORCE B-29 AIRCRAFT ATTRITION



| | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | CUM |
|---|---|---|---|---|---|---|---|---|---|---|
| On Bombing Missions - Combat | 1 | 10 | 17 | 11 | 5 | 33 | 27 | 23 | 3 | 130 |
| - Combat Opn'l | 1 | 8 | 4 | 8 | 10 | 9 | 29 | 11 | 10 | 90 |
| - Unknown | 2 | 2 | 6 | 5 | 14 | 14 | 30 | 9 | 3 | 85 |
| On Mining Missions | - | - | - | - | 5 | - | 5 | 1 | 6 | 17 |
| On Other Combat Missions | 1 | 2 | - | 3 | 1 | 1 | 1 | - | - | 9 |
| Total Combat Losses | 5 | 22 | 27 | 27 | 35 | 57 | 92 | 44 | 22 | 331 |
| % Of Combat Sorties | 1.3 | 3.7 | 4.2 | 2.8 | 1.3 | 1.6 | 2.0 | .8 | .4 | 1.3 |
| Trng & Misc Flights | - | - | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 15 |
| On Ground To E/A | 8 | 4 | - | - | - | - | - | - | - | 12 |
| War Weary A/C | - | - | - | - | 2 | 4 | - | 32 | 30 | 68 |
| Total Losses | 13 | 26 | 28 | 29 | 39 | 63 | 94 | 79 | 55 | 426 |
| % Of U/E | 20.9 | 29.0 | 19.6 | 13.9 | 15.0 | 18.5 | 19.9 | 15.0 | 8.9 | 15.8 |
| Replacement A/C Received | 1 | 12 | 33 | 38 | 25 | 90 | 83 | 123 | 92 | 497 |

ATTRITION

NOTE: In addition to the above, 13 F-13 A/C have been lost to date: 7 on combat missions, 3 on training & administrative flights, 1 on ground to enemy action, & 2 war-weary.
Included in Cumulative Misc. figure is 1 B-29 A/C asgd to Hq 20 AF which was lost on administrative flight.
Above figures do not include 8 A/C at Guam Air Depot awaiting return to U.S.





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## WING B-29 AIRCRAFT ATTRITION



| | 58TH WG | | | 73RD WG | | | 313TH WG | | | 314TH WG | | | 315TH WG | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUN | JUL | CUM | JUN | JUL | CUM | JUN | JUL | CUM | JUN | JUL | CUM | JUN | JUL | CUM |
| On Bombing Missions - Combat | 6 | 1 | 14 | 4 | - | 57 | 4 | - | 26 | 9 | 1 | 32 | - | 1 | 1 |
| - Combat Opn'l | 4 | 4 | 15 | 4 | 2 | 34 | - | 1 | 23 | 3 | 2 | 17 | - | 1 | 1 |
| - Unknown | 3 | - | 12 | 1 | 2 | 31 | 2 | - | 23 | 3 | - | 18 | - | 1 | 1 |
| On Mining Missions | - | - | - | - | - | - | 1 | 6 | 17 | - | - | - | - | - | - |
| On Other Combat Missions | - | - | - | - | - | 7 | - | - | 1 | - | - | - | - | - | 1 |
| Total Combat Losses | 13 | 5 | 41 | 9 | 4 | 129 | 7 | 7 | 90 | 15 | 3 | 67 | - | 3 | 4 |
| % Of Combat Sorties | 1.0 | .4 | 1.2 | .6 | .3 | 1.4 | .5 | .5 | 1.4 | 1.1 | .2 | 1.2 | - | .5 | .5 |
| Trng & Misc Flights | 1 | 1 | 3 | 1 | - | 3 | - | 1 | 4 | - | - | 2 | 1 | 1 | 2 |
| On Ground To E/A | - | - | - | - | - | 12 | - | - | - | - | - | - | - | - | - |
| War Weary A/C | 10 | 14 | 24 | 14 | 7 | 24 | 6 | 5 | 14 | 2 | 4 | 6 | - | - | - |
| Total Losses | 24 | 20 | 68 | 24 | 11 | 168 | 13 | 13 | 108 | 17 | 7 | 75 | 1 | 4 | 6 |
| % of U/E | 21.0 | 15.8 | 19.1 | 19.2 | 8.5 | 17.3 | 10.8 | 10.2 | 15.1 | 13.9 | 5.4 | 14.2 | 2.7 | 4.5 | 4.7 |
| Replacement A/C Received | 58 | 24 | 83 | 50 | 23 | 191 | 25 | 27 | 125 | 19 | 18 | 94 | - | - | 1 |

NOTE: Replacements exclude 23 A/C of 58th Wg, 70 A/C of 313th Wg and 60 A/C of 314th Wg which are regarded as "build-up" A/C.





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# AIR FORCE B-29 CREW ATTRITION



| | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | CUM |
|---|---|---|---|---|---|---|---|---|---|---|
| On Bombing Missions - Combat | 1 | 7 | 15 | 7 | 3 | 25 | 19 | 16 | 3 | 96 |
| - Combat Opn'l | - | 6 | 3 | 5 | 3 | 7 | 11 | 5 | 3 | 43 |
| - Unknown | 2 | 2 | 7 | 5 | 14 | 14 | 30 | 7 | 3 | 84 |
| On Mining Missions | - | - | - | - | 4 | - | 3 | - | 4 | 11 |
| On Other Combat Missions | 1 | - | - | 3 | 1 | - | 1 | - | - | 6 |
| Total Combat Losses | 4 | 15 | 25 | 20 | 25 | 46 | 64 | 28 | 13 | 240 |
| % Of Sorties | 1.3 | 2.5 | 3.9 | 2.0 | .9 | 1.3 | 1.4 | .5 | .2 | .9 |
| On Trng Missions | - | - | 1 | - | - | - | - | - | 2 | 3 |
| Reclass & Reorg | - | 3 | 3 | 10 | 4 | 16 | 14 | 13 | 15 | 78 |
| Relieved Upon Completion Of Tour | - | - | - | - | - | - | 6 | 63 | 145 | 214 |
| Total Losses | 4 | 18 | 29 | 30 | 29 | 62 | 84 | 104 | 175 | 535 |
| % Of U/E | 6.4 | 20.0 | 20.3 | 14.4 | 11.2 | 18.2 | 17.5 | 19.7 | 28.4 | 19.6 |
| Replacement Crews Received | 1 | 5 | 13 | 37 | 97 | 103 | 106 | 148 | 171 | 681 |

NOTE: In addition to the above, 9 B-13 crews have been lost to date: 3 on combat missions, 1 on misc flight and 5 to reclassification and reorganization.

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## WING B-29 CREW ATTRITION



| | 58TH WG | | | 73RD WG | | | 313TH WG | | | 314TH WG | | | 315TH WG | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUN | JUL | CUM | JUN | JUL | CUM | JUN | JUL | CUM | JUN | JUL | CUM | JUN | JUL | CUM |
| On Bombing Missions - Combat | 5 | 1 | 10 | 2 | - | 47 | 3 | - | 12 | 6 | 1 | 26 | - | 1 | 1 |
| - Combat Opn'l | 2 | 1 | 6 | - | 1 | 19 | - | - | 8 | 3 | - | 9 | - | 1 | 1 |
| - Unknown | 3 | - | 12 | 1 | 2 | 31 | - | - | 22 | 3 | - | 18 | - | 1 | 1 |
| On Mining Missions | - | - | - | - | - | - | - | 4 | 11 | - | - | - | - | - | - |
| On Other Combat Missions | - | - | - | - | - | 4 | - | - | 1 | - | - | - | - | - | 1 |
| Total Combat Losses | 10 | 2 | 28 | 3 | 3 | 101 | 3 | 4 | 54 | 12 | 1 | 53 | - | 3 | 4 |
| % Of Sorties | .8 | .2 | .8 | .2 | .2 | 1.1 | .2 | .3 | .8 | .9 | .1 | 1.0 | - | .5 | .5 |
| On Trng Missions | - | 1 | 1 | - | - | - | - | - | 1 | - | - | - | - | 1 | 1 |
| Reclass & Reorg | 8 | 1 | 12 | 1 | 4 | 27 | 4 | 6 | 28 | - | 4 | 11 | - | - | - |
| Relieved Upon Completion Of Tour | 22 | 49 | 71 | 41 | 66 | 113 | - | 25 | 25 | - | 5 | 5 | - | - | - |
| Total Losses | 40 | 53 | 112 | 45 | 73 | 241 | 7 | 35 | 108 | 12 | 10 | 69 | - | 4 | 5 |
| % Of U/E | 34.9 | 41.9 | 31.4 | 36.1 | 56.3 | 24.8 | 5.8 | 27.5 | 15.1 | 9.8 | 7.8 | 13.0 | - | 4.5 | 3.9 |
| Replacement Crews Received | 52 | 59 | 155 | 45 | 62 | 227 | 33 | 29 | 164 | 18 | 21 | 135 | - | - | - |

NOTE: Replacemcnts exclude 15 crews of 313th Wg regarded as "build-up" crews.

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| | | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | CUM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of B-29 A/C Lost & Battle Damaged Due to Enemy Reaction: | Fighters | 4 | 29 | 81 | 54 | 12 | 87 | 60 | 54 | 14 | 395 |
| | Flak | 3 | 42 | 20 | 69 | 197 | 362 | 512 | 527 | 220 | 1952 |
| | Fighters & Flak | 2 | 16 | 25 | 15 | 9 | 92 | 47 | 54 | 3 | 263 |
| | Self Inflicted | 3 | 6 | 11 | 7 | 1 | 10 | 10 | 12 | 1 | 61 |
| | Unknown (Losses Only) | 2 | 2 | 6 | 5 | 14 | 14 | 31 | 9 | 6 | 89 |
| | Total | 14 | 95 | 143 | 150 | 233 | 565 | 660 | 656 | 244 | 2760 |
| % of B-29 A/C over Target Lost & Battle Damaged Due to Enemy Reaction: | Fighters | 2.3 | 9.2 | 21.5 | 8.8 | .5 | 2.9 | 1.5 | 1.1 | .2 | 1.8 |
| | Flak | 1.7 | 13.3 | 5.3 | 11.3 | 8.4 | 11.9 | 12.8 | 10.6 | 3.8 | 9.0 |
| | Fighters & Flak | 1.1 | 5.1 | 6.6 | 2.5 | .4 | 3.0 | 1.2 | 1.1 | .1 | 1.2 |
| | Self Inflicted | 1.7 | 1.9 | 2.9 | 1.1 | .04 | .3 | .2 | .2 | .02 | .3 |
| | Unknown | 1.1 | .6 | 1.6 | .8 | .6 | .5 | .8 | .2 | .1 | .4 |
| | Total | 8.0 | 30.1 | 38.0 | 24.5 | 9.9 | 18.6 | 16.5 | 13.2 | 4.2 | 12.7 |
| B-29's Lost To Enemy A/C | | 1 | 7 | 13 | 8 | - | 11 | 8 | 6 | 1 | 55 |
| Enemy A/C Claimed Destroyed | | 7 | 49 | 140 | 71 | 15 | 201 | 131 | 95 | 3 | 712 |
| Enemy A/C Destroyed Per B-29 Lost To Enemy A/C | | 7.0 | 7.0 | 10.8 | 8.9 | - | 18.3 | 16.4 | 15.8 | 3.0 | 12.9 |
| # Enemy Attacks | | 185 | 1597 | 2963 | 1341 | 445 | 2414 | 1278 | 1554 | 78 | 11855 |
| # Attacks Per B-29 Lost To Enemy A/C | | 185 | 228 | 228 | 168 | - | 219 | 160 | 259 | 78 | 216 |
| # Attacks Per Enemy A/C Destroyed | | 26 | 33 | 21 | 19 | 30 | 12 | 10 | 16 | 26 | 17 |





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PERCENTAGE DISTRIBUTION OF CREW-CREDIT SORTIE EXPERIENCE TO DATE FOR A/P COMMANDERS AND PILOTS



| | 0 | 1-5 | 6-10 | 11-15 | 16-20 | 21-25 | 26-27 | 28-29 | 30-31 | 32-33 | 34-35 | Over 35 | # Crews On Hand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58TH WG | 12.1 | 22.0 | 19.1 | 14.4 | 7.2 | 10.0 | 4.6 | 3.0 | 3.4 | 1.9 | 2.3 | - | 250 |
| 73RD WG | 18.3 | 17.1 | 13.9 | 10.6 | 9.0 | 10.0 | 2.2 | 6.3 | 5.7 | 4.9 | 2.0 | - | 235 |
| 313TH WG | 6.1 | 13.8 | 8.3 | 11.4 | 18.4 | 13.2 | 8.7 | 6.5 | 7.9 | 4.5 | 1.2 | - | 246 |
| 314TH WG | 6.4 | 8.7 | 7.9 | 14.0 | 22.2 | 21.6 | 8.1 | 4.7 | 1.6 | 2.6 | 2.2 | - | 256 |
| 315TH WG | 24.8 | 35.0 | 39.6 | .6 | - | - | - | - | - | - | - | - | 161 |
| AIR FORCE TOTAL | 12.6 | 18.2 | 16.2 | 11.0 | 12.1 | 11.8 | 5.1 | 4.4 | 4.0 | 2.9 | 1.7 | - | 1148 |
| Desired Distribution | 8.2 | 15.7 | 14.8 | 14.0 | 13.3 | 12.7 | 4.9 | 4.8 | 4.7 | 4.6 | 2.3 | - | - |

NOTE: Command & Staff Personnel and Killed, Missing or Evacuated Personnel are not included. However, Lead Crew Personnel at school in U.S. are included.

AIR-SEA RESCUE ACTIVITY *Includes bailouts over Iwo Jima.

| | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | CUM |
|---|---|---|---|---|---|---|---|---|---|---|
| Pers'l Known To Have Gone Down At Sea | 36 | 179 | 155 | 136 | 107 | 167 | 230 | 180 | 120 | 1310 |
| Number Rescued | 14 | 63 | 20 | 65 | 79 | 55 | 110 | 92 | 73 | 571 |
| % Rescued | 38.9 | 35.2 | 12.9 | 47.8 | 73.8 | 32.9 | 47.8 | 51.1 | 60.8 | 43.6 |
| Pers'l Failing To Return From Missions | 70 | 227 | 279 | 259 | 312 | 516 | 764 | 390 | 210 | 3027 |
| Number Rescued | 14 | 63 | 20 | 65 | 79 | 55 | 183* | 102* | 73 | 654* |
| % Rescued | 20.0 | 27.8 | 7.2 | 25.1 | 25.3 | 10.7 | 24.0 | 26.2 | 34.8 | 21.6 |





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COMMANDING GENERAL - Lieutenant General N. F. Twining

CHIEF OF STAFF - Colonel R. K. Taylor

| | | | | | |
|---|---|---|---|---|---|
| D C/S Operations | - Col J B Montgomery | D C/S Sup & Maint | - Col C S Irvine | D C/S Admin | - Col J de P T Hills |
| Asst C/S A-3 | - Col W H Blanchard | Sup Contlr & A-4 | - Col J Morris | Asst C/S A-1 | - Lt Col D P Hatch |
| Tactics | - Col H R Sullivan | Engineering Contlr | - Col D Coupland | Adj General | - Maj J S Chapman |
| Training | - Lt Col R C Williams | Maint Engineering | - Col W M Knowles | Chaplain | - Lt Col J C Sides |
| Operations | - Lt Col J W Guthrie | Opn'l Engineering | - Lt Col B H Warren | Finance | - Capt K K Kilgore |
| Asst C/S A-2 | - Col J D Garcia | Engineer | - Col W E Robinson | Historian | - Maj L F Moore |
| Photo | - Col G G Northrup | Supply | - Maj H Pipe | Info & Education | - Capt H B Travis |
| Communications | - Col A T Wilson | Chemical | - Col T P Gahan | Judge Advocate | - Col H T Fitch |
| Radar Advisor | - Col G F Metcalf | Ordnance | - Lt Col H P Hesler | Provost Marshal | - Maj H A Patnaude |
| Weather | - Col J T Seaver | Signal | - Lt Col J M Craddock | Public Relations | - Maj F N Finney |
| | | | | Special Services | - Maj G S Johnson |
| | | | | Hq Commandant | - Maj M S Fisher |

| | | | |
|---|---|---|---|
| D C/S Plans | - Col P S Emrick | Air Inspector | - Col F W Ott |
| Requirements | - Lt Col J A Potentler | Surgeon | - Col H H Twitchell |
| Org & Movement | - Lt Col E M Lightfoot | Operations Analyst | - Dr. L C Brothers |
| Special Projects | - Not Appointed | Statistical Control | - Maj H Odell |

PERSONNEL



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## WING STAFF PERSONNEL



| | | | |
|---|---|---|---|
| Commanding General | 58TH WG – Brig Gen R M Ramey | 73RD WG – Brig Gen E O'Donnell | |
| Chief of Staff | Col D O Monteith | Col W G Sweeney | |
| D C/S for Operations | Col T E Moore | Col J R Sutherland | |
| D C/S for Supply & Maint | Lt Col R E Greer | Col G E Schaetzel | |
| D C/S for Administration | Lt Col C N Guttenberger | Col K M Landon | |
| A-1 | Lt Col N P Mortensen | Lt Col L T Love | |
| A-2 | Lt Col S S Terry | Lt Col C Snow | |
| A-3 | Lt Col F G Wilson | Lt Col W E Beightol | |
| Supply Controller | Lt Col D S Williams | Col H W Shelmire | |
| Maintenance Controller | Lt Col B H Burns | Maj E D Grana | |

| | | | |
|---|---|---|---|
| Comdg Gen | 313TH WG – Brig Gen J H Davies | 314TH WG – Col C R Storrie | 315TH WG – Brig Gen F A Armstrong |
| C/S | Col D W Eisenhart | Col D E Muehleisen | Col L S Stranathan |
| D C/S Opns | Col D E Wilson | Col H T Wheless | Col W A Miller |
| D C/S S&M | Col C P Conner | Col C P Sheffield | Col E T Kennedy |
| D C/S Admin | Col L W Proper | Col L H Hunt | Col D T Carney |
| A-1 | Lt Col C H Brown | Lt Col R W Dickson | Lt Col L Kilbourne |
| A-2 | Lt Col H D Kenzie | Lt Col H W Besse | Lt Col S S Bartlett |
| A-3 | Lt Col O J Ponge | Lt Col J R Maney | Lt Col T C Parkinson |
| Supply Controller | Lt Col C F Macomber | Lt Col G R Bailey | Maj W D Carlos |
| Maint Controller | Col G J Schriever | Col J L M Des Islets | Col L W Fulton |





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## GROUP KEY PERSONNEL



| | Group Commander | Deputy Commander | Executive | S-3 |
|---|---|---|---|---|
| 58TH WG – 40th Gp | Col W K Skaer | Lt Col O R Schaaf | Lt Col W G Shutters | Maj W G Renfro |
| 44th Gp | Col J C Selser | Lt Col A N Moore | Maj R B Hensley | Lt Col W R Close |
| 462nd Gp | Col A F Kalberer | Lt Col R L Randolph | Lt Col R L Norman | Lt Col T P Vaucher |
| 468th Gp | Col J V Edmundson | Lt Col J R East | Lt Col F L Andry | Maj F W Nye |
| 73RD WG – 497th Gp | Col A T Johnson | Lt Col N D Van Sickle | Lt Col N J Campbell | Lt Col A L Haley |
| 498th Gp | Col W D Ganey | Lt Col D W Saunders | Maj C R Roberts | Lt Col W F Todd |
| 499th Gp | Col M J Lee | Lt Col W E Chambers | Maj G C Sturgeon | Lt Col J M Wilkinson |
| 500th Gp | Col J E Dougherty | Lt Col W L McDowell | Lt Col H Adamson | Lt Col F A Parsons |
| 313TH WG – 6th Gp | Col K H Gibson | Lt Col T W Tucker | Maj R P Tatum | Maj L M Sowers |
| 9th Gp | Col H C Huglin | Lt Col W L Hall | Lt Col A L Perry | Lt Col F L Luschen |
| 504th Gp | Col G W Martin | Lt Col H F Hugos | Lt Col C P Tilton | Lt Col H T Shelton |
| 505th Gp | Lt Col C M Eisenhart | Lt Col R E Blauw | Lt Col C F Heidrick | Lt Col J R Wilcox |
| 314TH WG – 19th Gp | Col J A Roberts | Lt Col G T Chadwell | Lt Col J C Wilson | Maj H C Mailey |
| 29th Gp | Lt Col R J Mason | Lt Col L D Briggs | Lt Col D S Washington | Maj H L Evans |
| 39th Gp | Col G W Mundy | Lt Col F P Sturdivant | Lt Col J E Condron | Lt Col J H Thompson |
| 330th Gp | Col E D Reynolds | Lt Col D C Polhamus | Lt Col L H Vereen | Lt Col C P Walter |
| 315TH WG – 16th Gp | Lt Col A Castellotti | Lt Col C H Davidson | Maj R C Hopsak | Maj Z S Smith |
| 331st Gp | Col J N Peyton | Lt Col R J Barnick | Lt Col G B Mackey | Maj H E Moore |
| 501st Gp | Col B Hubbard | Lt Col A G Campbell | Lt Col H R Striegler | Lt Col L R McGehee |
| 502nd Gp | Col K O Sanborn | Lt Col F R Pancake | Lt Col T H Joyce | Lt Col F W Iseman |





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20th Air Force
Chart of Air Raids by American B/C
Nov. 1944 thru August 1945

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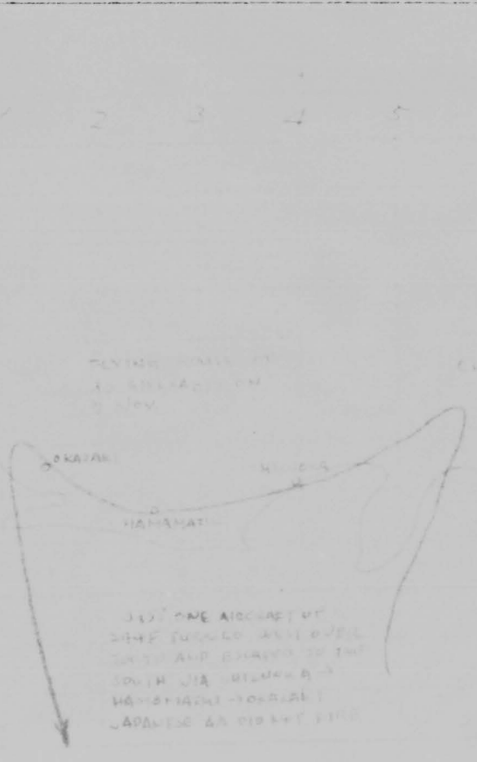



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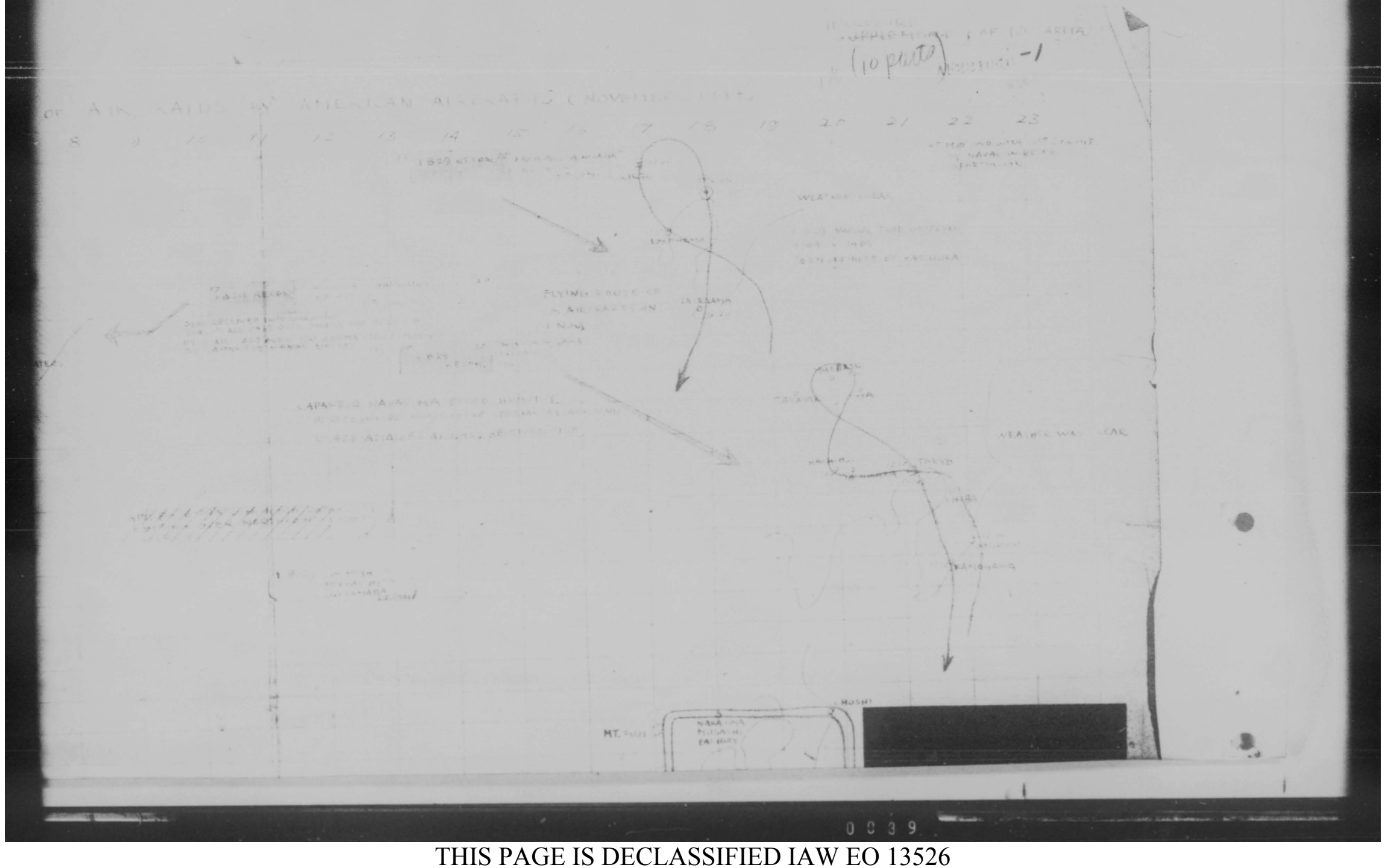


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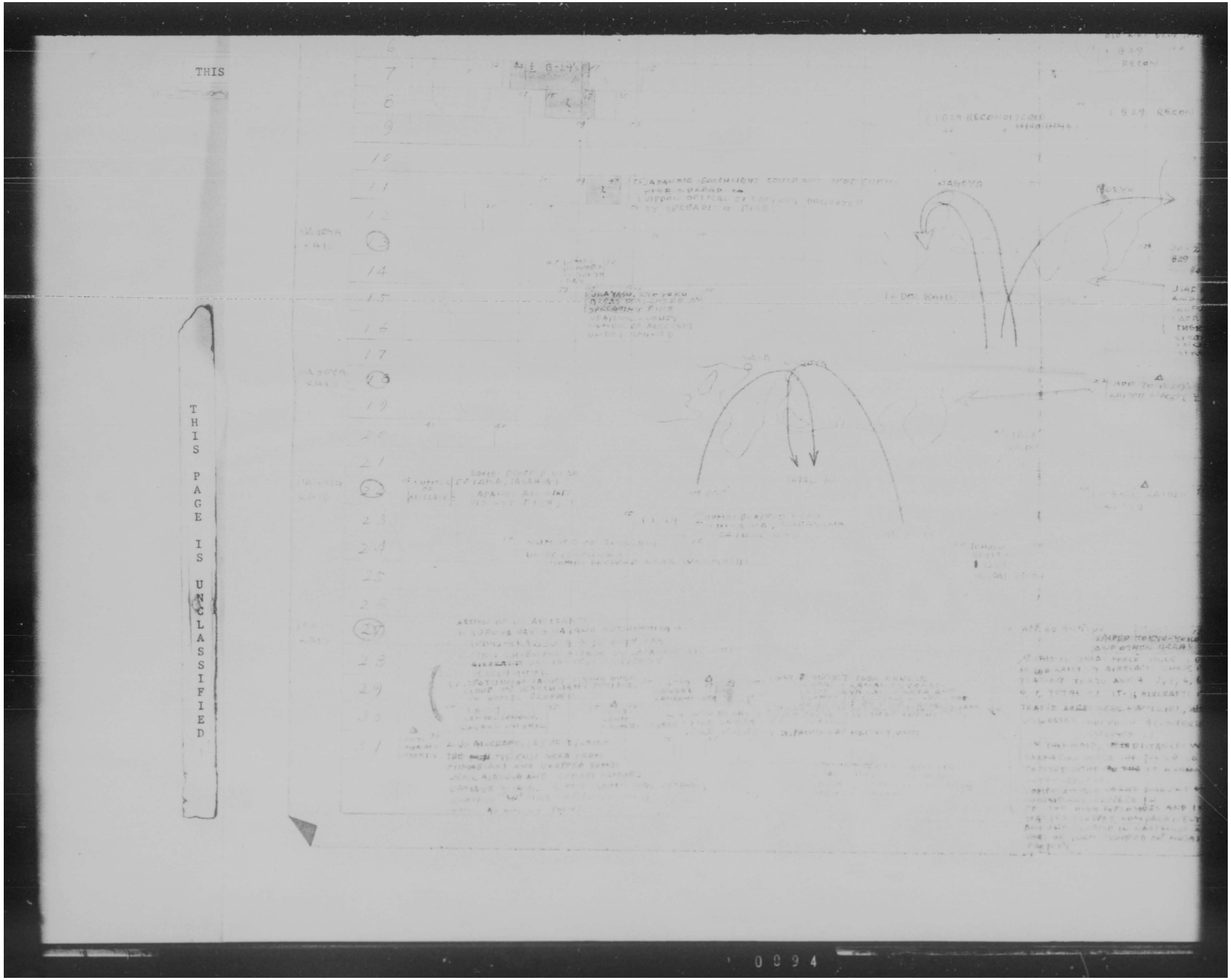


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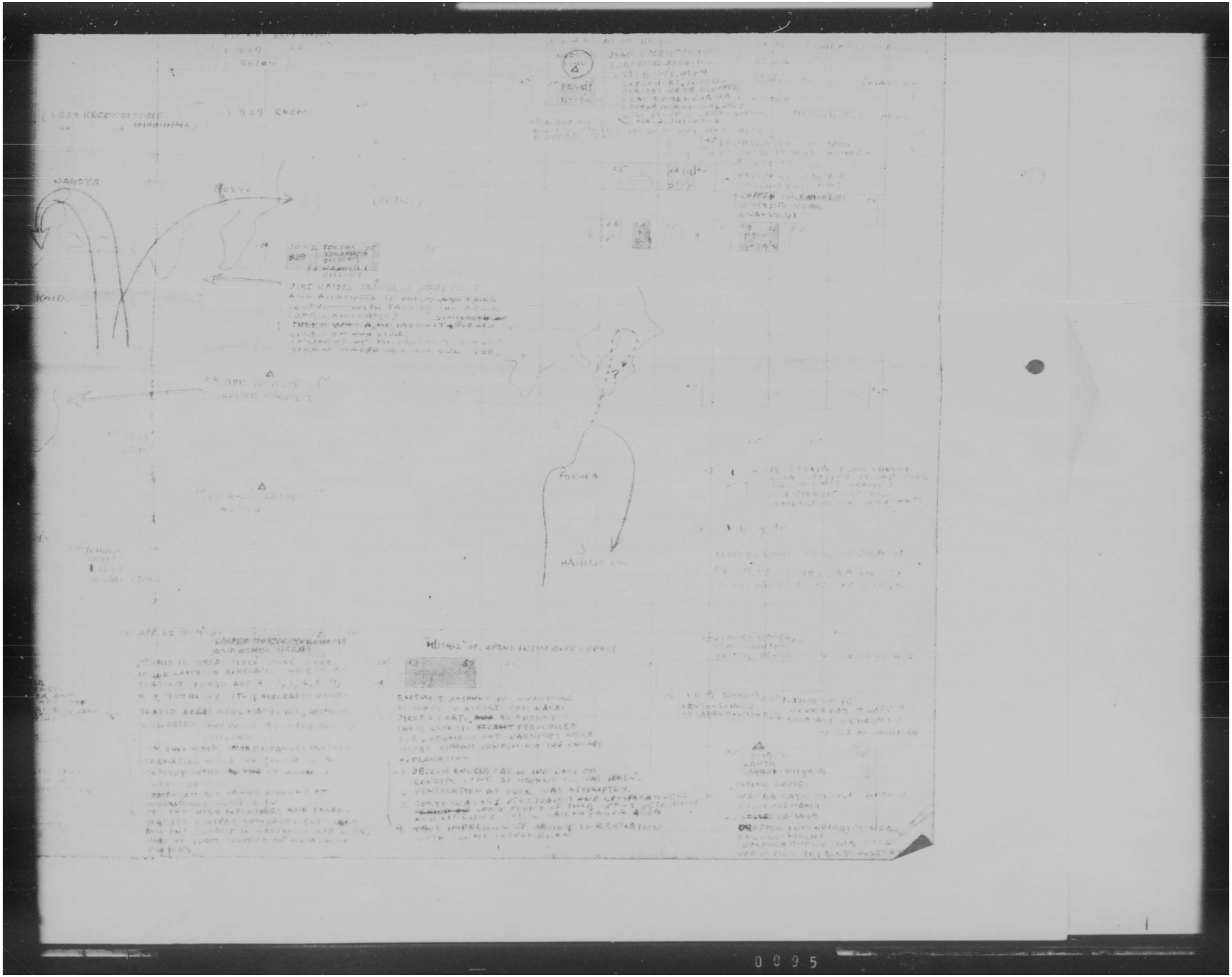


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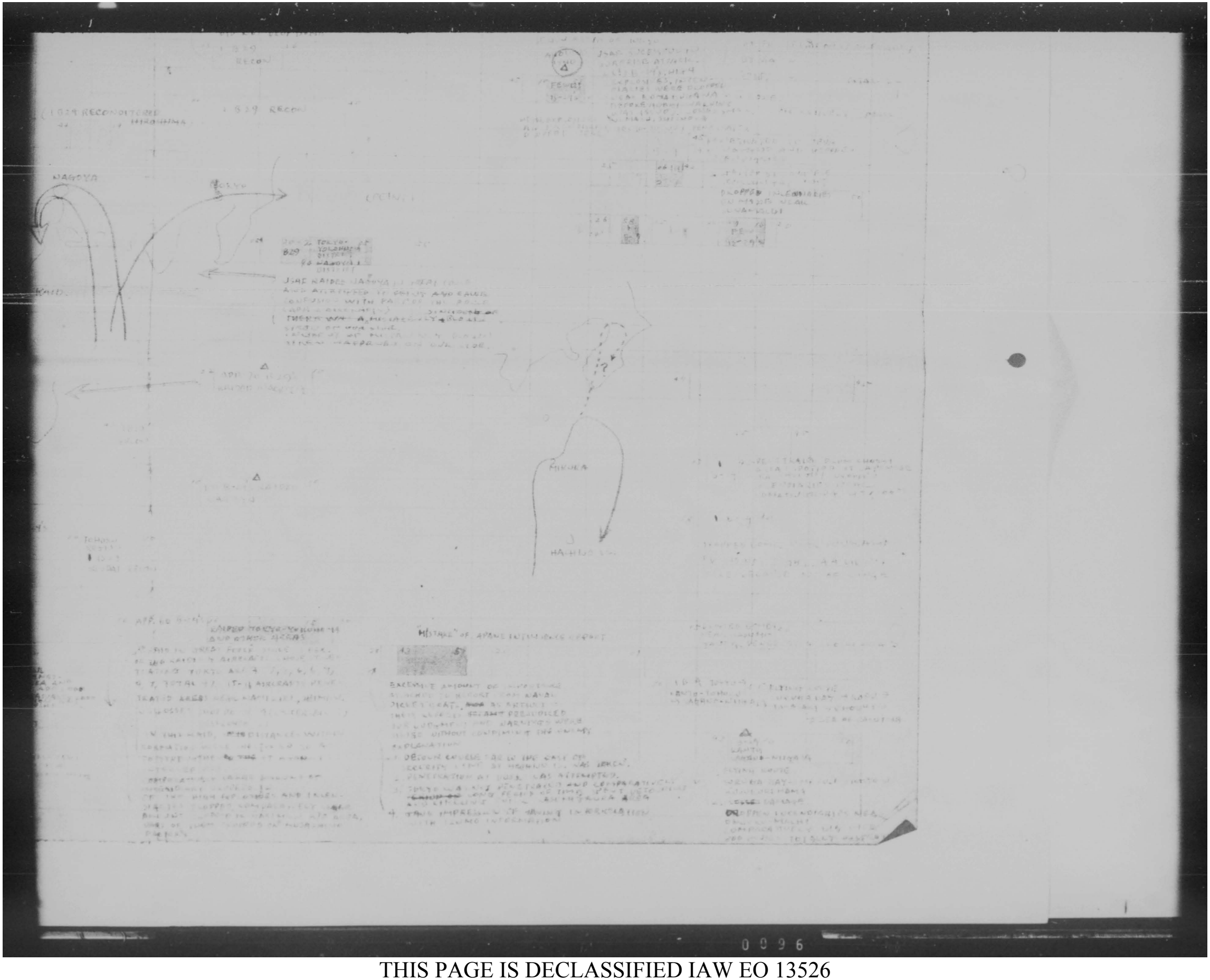


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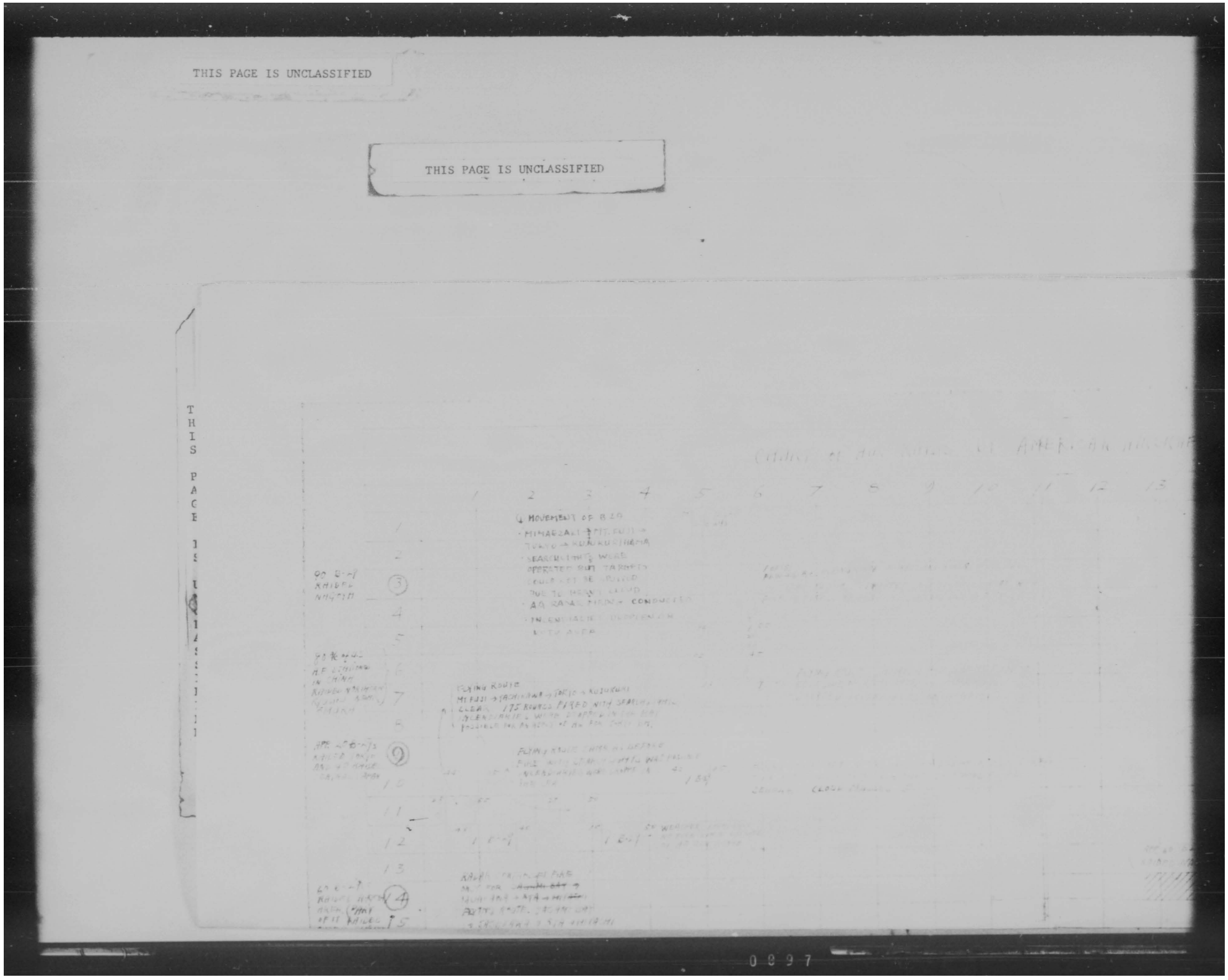


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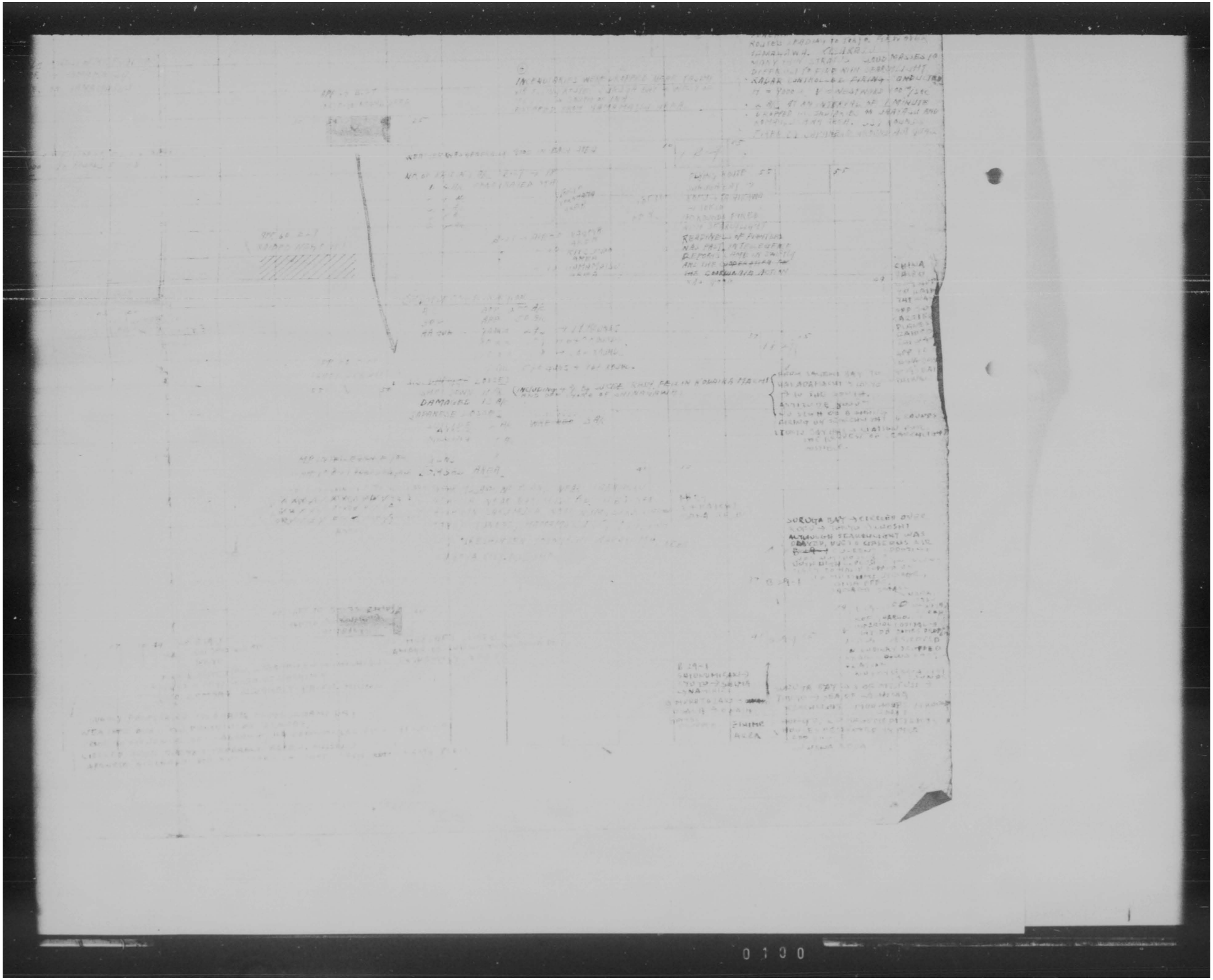


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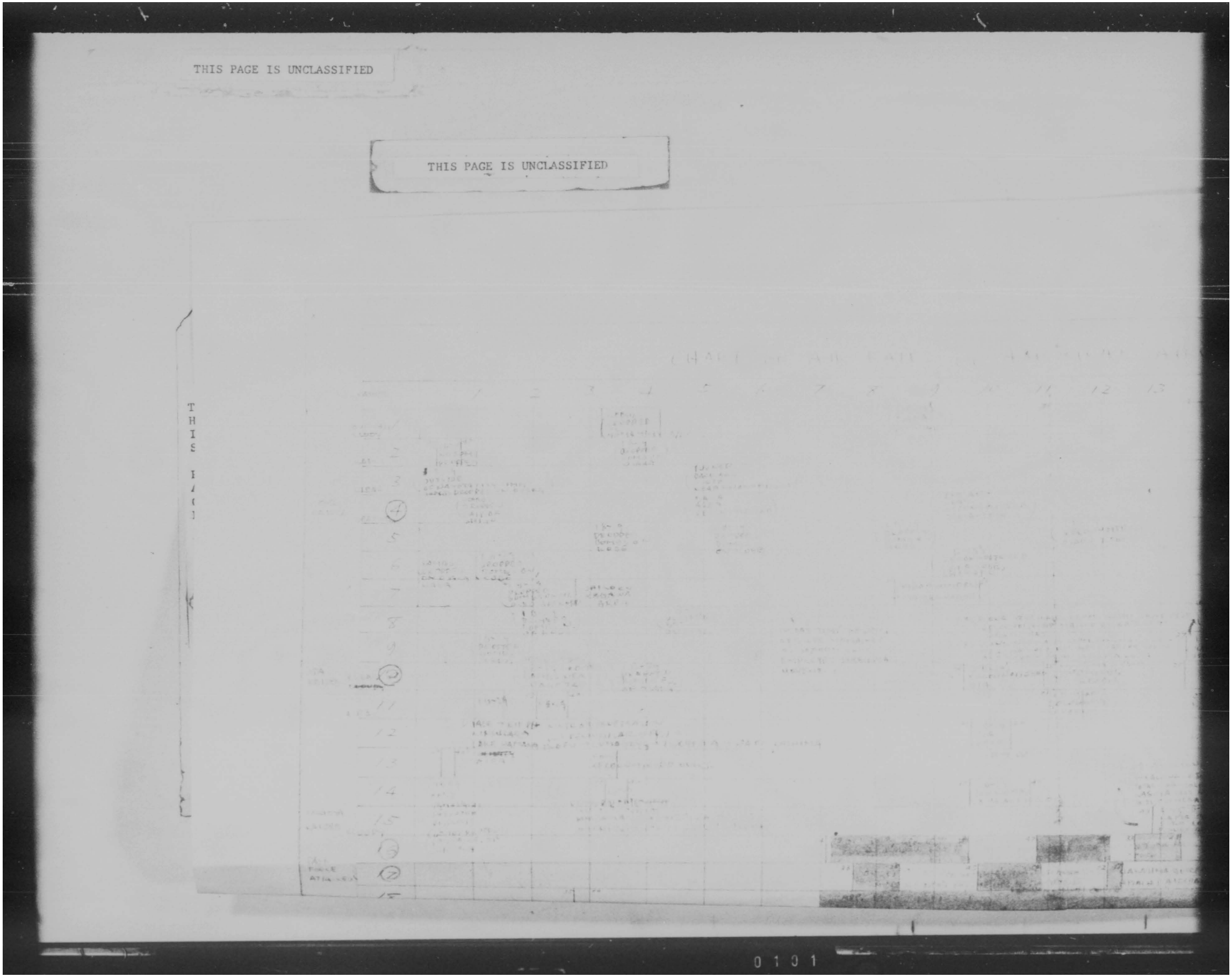

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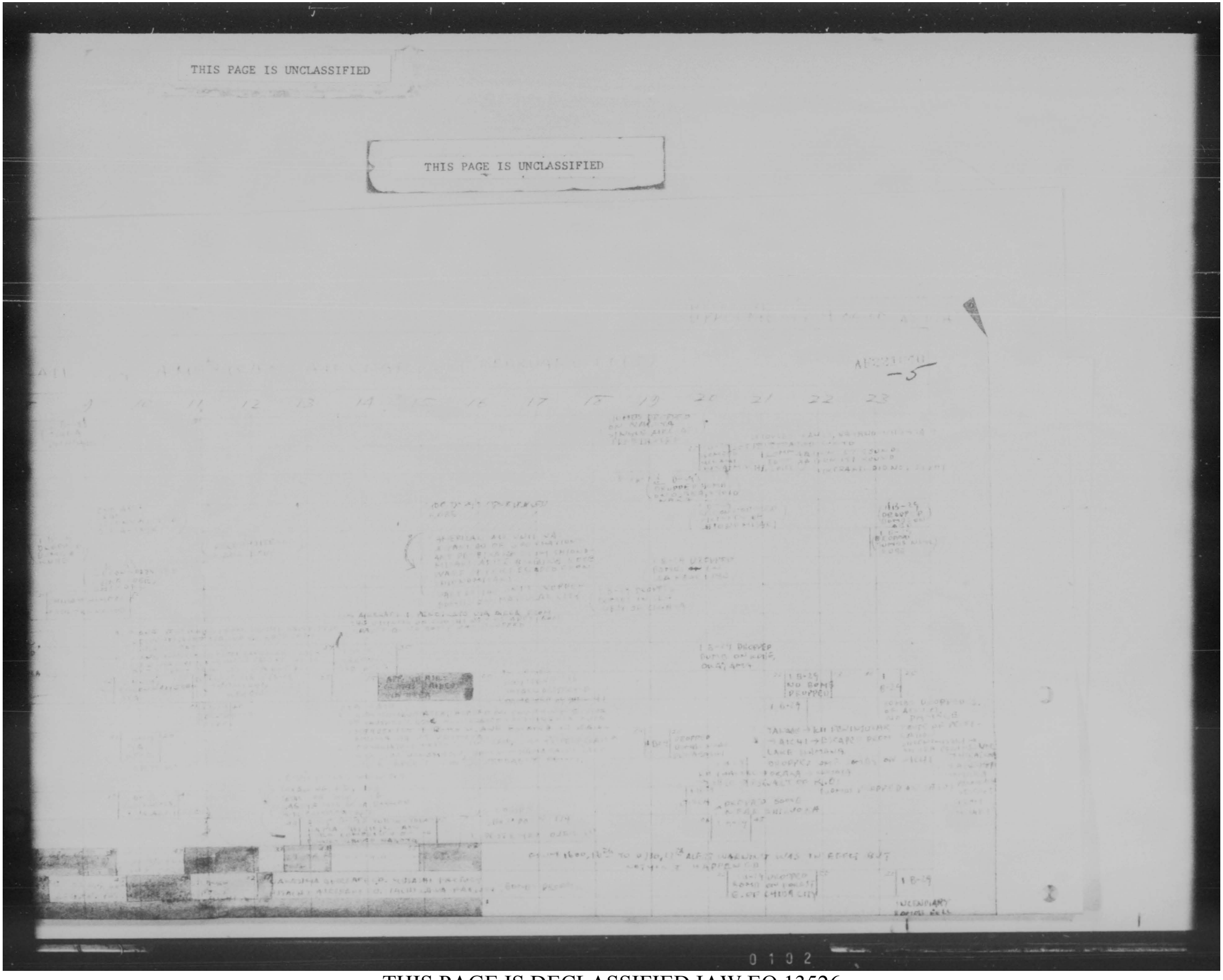



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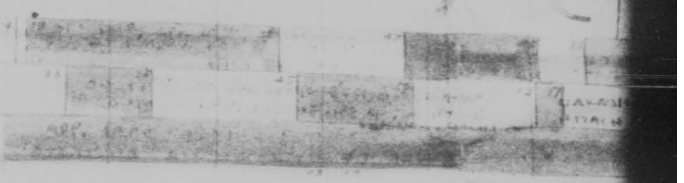

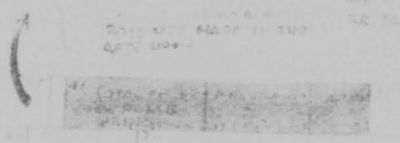

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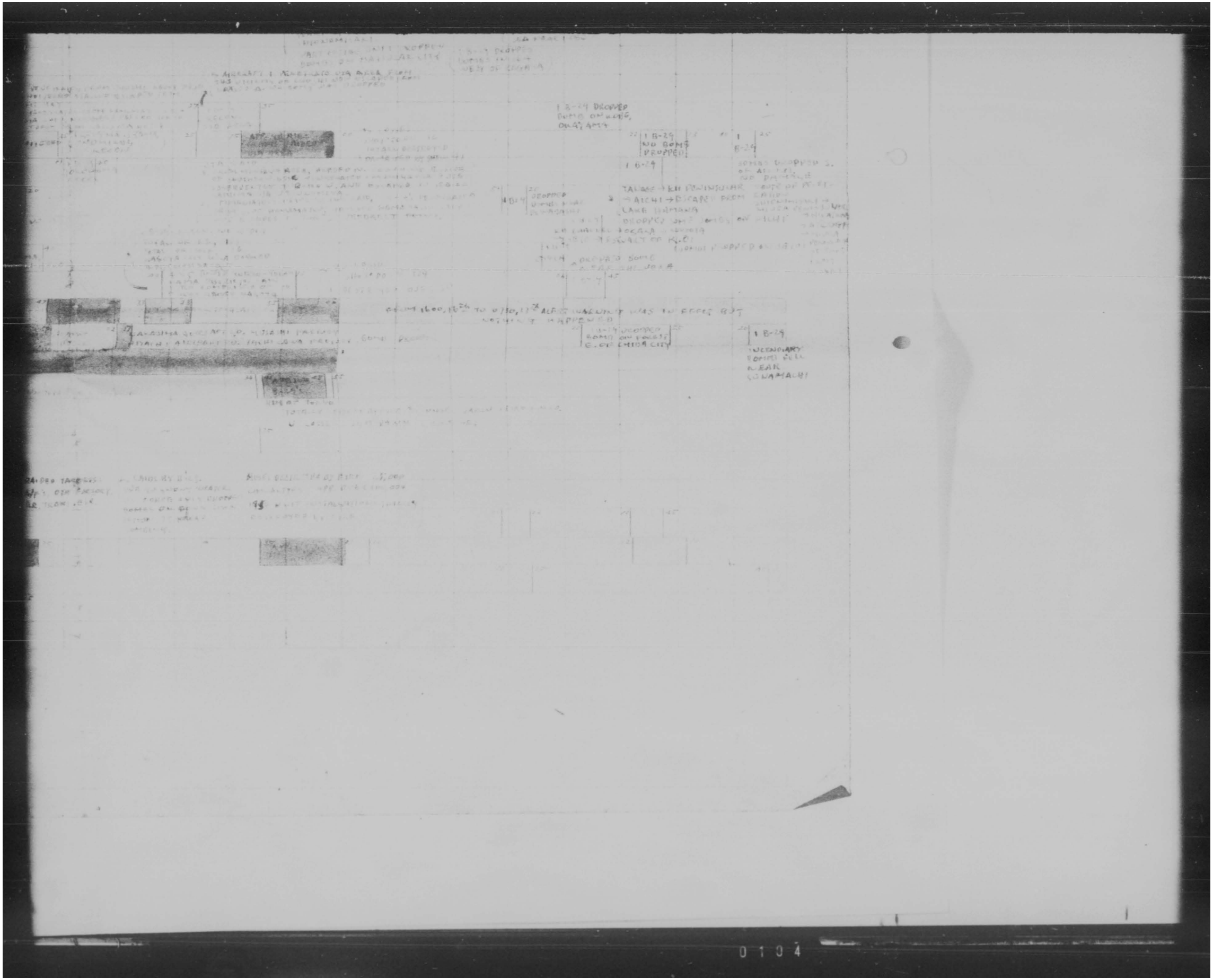


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CHART OF AIR RAIDS MADE BY AMERICAN AIRC

1 2 3 4 5 6 7 8 9 10 11 12

MARCH 1 TOKYO RAID

DUE TO BAD WEATHER (SNOW) JAPANESE AIRCR
WHOLLY DEPENDED ON RADAR CONTROLLED AA
AMERICAN AIR FORCE DISPATCHED CHIEFS OVE
(2 PLANES FLEW SINGLY) AND THE NAVY FO
AREA AND ITS VICINITY IN 4 WAVES

PROGRE

1ST
2ND
3RD
4TH

1 B-29 YAMANASHI, SHIZUOKA → HAMAMATSU → WESTERN SHIZUOKA → TO SEA

ABOUT 150 B-29 RAIDED TOKYO

8-9 B-29 CIRCLED THE RIM OF TOKYO ONE BY ONE AND BOMBED

1 B-29 HAMAMATSU → ASHIZU → TOKYO → KANDUAWA

BOMBED N OF TACHIKAWA

MARCH 10 TOKYO RAID

ABOUT 130 B-29 START CRUISED AMERICANS PENETRATED LOW ALTITUDE OF ... WHICH DIFFERED FROM THEIR PRACTICE NEITHER IT HIT BY AA VERIFIED AA FIRE WAS EFFECTIVE WITH THE HELP OF SEARCHLIGHT

DAMAGE TO TOKYO
CONFLAGRATION BURNED 24,000 UNITS
CASUALTIES APPROX 130,000
DEAD OR MISSED 83,000
(MAJORITY BURNED TO DEATH)
GREATER PORTION OF AREA BETWEEN SUMIDA R. & ARA R. BURNED OUT
INCENDIARY BOMB FELL INSIDE IMPERIAL PLACE
12 AIR DIVISIONS BURNED OUT
B-29 MARIAS INCENDIARY BOMB USED IN ATTACK AGAINST CITIES

1 B-29 AND BOMB DROPPED

WAXING MOON

TOKYO RAIDED (10) ABOUT 130 B-29 RAIDED TOKYO AREA

NAGOYA RAIDED (12) ABOUT 130-B29 ATTACKED NAGOKA

OSAKA RAIDED (14) ABOUT 90 B-29 ATTACKED OSAKA

KOBE RAIDED (17) ABOUT 70 B-29 ATTACKED KOBE

WARNING ISSUED IN EXPECTATION OF ATTACK
JAPANESE AMERICAN AIRCRAFT DID NOT

1 B-29 YAMANASHI → NAGOYA → SUKUSA BAY
(NOTHING MORE REPORTED)

TASK FORCE ATTACKED WESTERN MILITARY DISTRICT AND E-54

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INCLOSURE NO. 5 TO ATIS

BY AMERICAN AIRCRAFT (MARCH 1945)

ENCLOSURE
-6

B 1 10 11 12 13 14 15 16 17 18 19 20 21 22 23

MARCH 4 TOKYO RAID

1 DUE TO BAD WEATHER (SNOW) JAPANESE AIRCRAFT NOT ABLE TO FIGHT
2 AMERICAN AIR FORCE DROPPED CHAFF OVER THE SECURITY ZONE BY FEW PLANES
(5 PLANES FLEW SINGLY) AND THE MAIN FORCE PENETRATED THE TOKYO-YOKOHAMA AREA AND ITS VICINITY IN 3 WAVES

ABOUT 150 B-29 RAIDED TOKYO

PROGRESS OF ATTACK

1ST ECHELON (ABOUT 50 PLANES) 4 FORMATIONS
HINAI ZAKI → TENRYU R. → HAMAMATSU → TOKYO → CHOSHI
2ND ECHELON (ABOUT 50 PLANES) 4 FORMATIONS
SURUGA BAY → KOFU → KAWAGUCHI → TOKYO → TOBANE
3RD ECHELON (ABOUT 30 PLANES) 3 FORMATIONS
INA → ATAMI → TOKYO → MUTSUKURIJAMA
4TH ECHELON (ABOUT 30 PLANES) 3 FORMATIONS
HAMAMATSU → KOFU → TOKYO → CHOSHI

1 B-29 → HAMAMATSU → MIYAZU → HACHIOJI → KANAGAWA →

1 B-29 → CIRCLED OVER IZU PENINSULAR → KOFU → NW KANTO AND ESCAPED VIA SAGAMI BAY

3 B-29 PENETRATED TOKYO-YOKOHAMA AREA AND IZU PENINSULAR AND NORTH AND CLEARED THRU CHOSHI

1 B-29 → PROBABLY RECONNAISSANCE → BOMB UNLOADED

NO PENETRATION MADE → FEW AIRCRAFT APPROACHED OVER OCEAN BUT DID NOT PENETRATE JAPANESE HOMELAND

WARNING ISSUED IN EXPECTATION OF ATTACK BY TASK FORCE AMERICAN AIRCRAFT DID NOT ATTACK

1 B-29 → TAKAYAMA → GIFU → SURUGA BAY
(NAGANO AREA RAIDED)

ATTACKED WESTERN MILITARY DISTRICT AND B-54

1 B-29
NAGOYA → INA → UEDA → KOFU → SURUGA BAY → YAMANASHI SHIZUOKA
DROPPED BOMBS OF MATSUMOTO

3 B-29
SHIZUOKA, KANTO AREA
1 PLANE SHIMIZU → CIRCLED NW IZU PENINSULAR → DROPPED BOMBS ON EASTERN PART OF IZU
2ND PLANE CIRCLED OVER SHIKAWANA → TOKYO → KASUMIGA-URA AND DROPPED BOMS ON CHOSHI
3RD PLANE CIRC. TO OVER HAMAMATSU → KUMAZU → IZU PENINSULAR → AND SHIMODA

WESTERN JAPAN ATTACKED BY TASK FORCE WESTERN AND CENTRAL JAPAN ATTACKED BY

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WAXING MOON

8
9
TOKYO RAIDED — 10 — ABOUT 130 B-29 RAIDED TOKYO AREA
11
NAGAYA RAIDED — 12 — ABOUT 130-B29 ATTACKED NAGOYA
13
OSAKA RAIDED — 14 — ABOUT 90 B-29 ATTACKED OSAKA
15
16
KOBE RAIDED — 17 — ABOUT 70 B-29 ATTACKED KOBE
18
NAGOYA RAIDED — 19 — ABOUT 170 B-29 ATTACKED NAGOYA
20
21
22
23
24
NAGOYA RAIDED — 25 — NAGOYA ATTACKED
26
NORTHERN KYUSHU RAIDED — 27
28 — NORTHERN KYUSHU ATTACKED
29
30
31
REMARKS

AMERICANS PENETRATED AT LOW ALTITUDE OF 2000~3000 M. WHICH DIFFERED FROM THEIR PRACTICE HITHERTO.
HIT BY AA VERIFIED
AA FIRE WAS EFFECTIVE WITH THE HELP OF SEARCHLIGHT
DAMAGE TO TOKYO
COMPLETELY BURNED 250,000 UNITS
CASUALTIES APPROX 130,000
DEAD OR WOUNDED ROUGHLY 10,000
(MAJORITY BURNED TO DEATH)
GREATER PORTION OF AREA BETWEEN SUMIDA R. & ARA R. BURNED OUT
INCENDIARY BOMB STILL INSIDE IMPERIAL PLACE
1ST AIR DIV 452 BURNED OUT
103 B M47-A2 INCENDIARY BOMB USED IN ATTACK AGAINST CITIES
BOMB NOT DROPPED MAY HAVE BEEN WEATHER RECONNAISSANCE

WARNING ISSUED IN EXPECTATION OF ATTACK BY TASK FORCE AMERICAN AIRCRAFT DID NOT ATTACK

TOTAL OF 7TH RAIDS BY TASK FORCE



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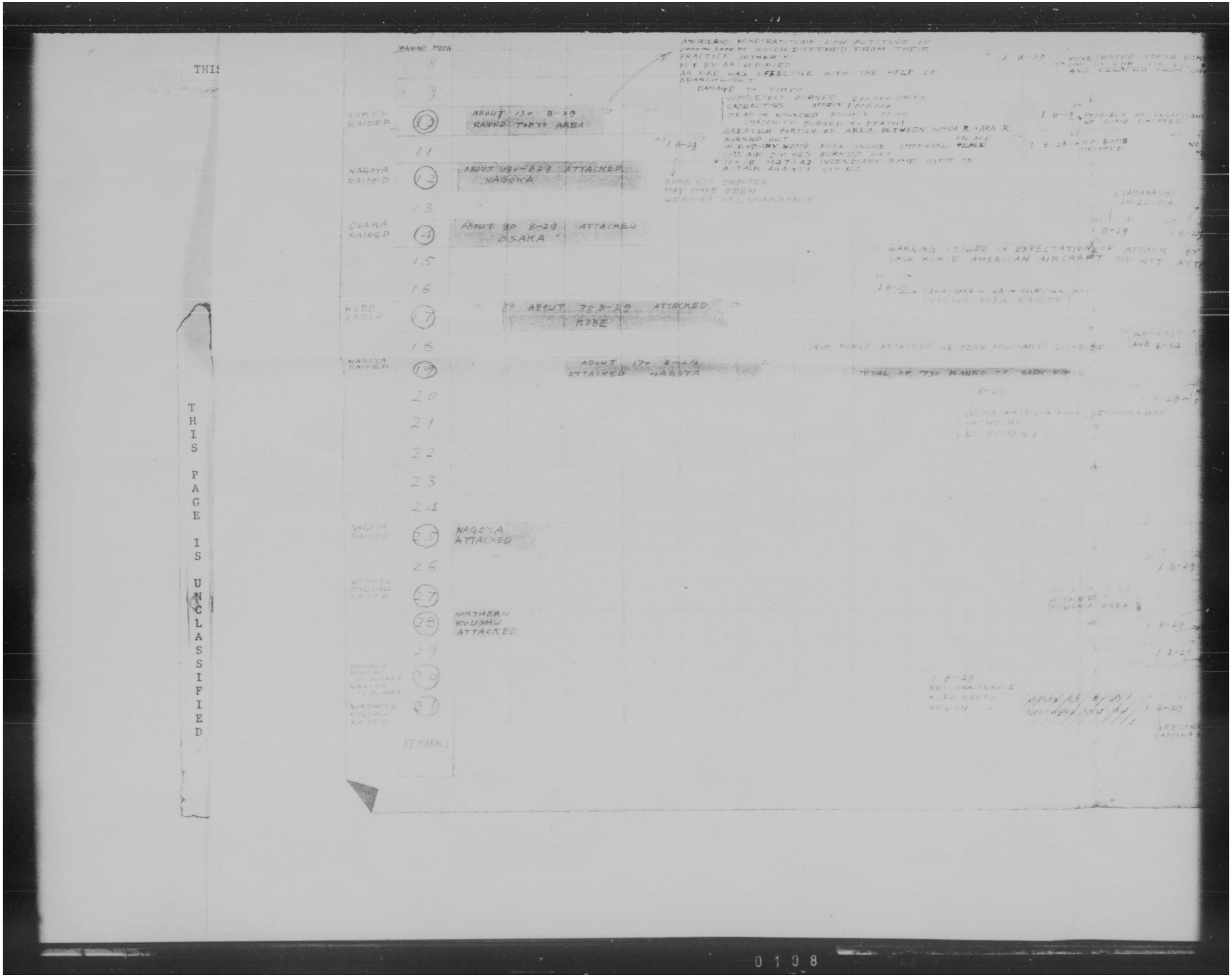


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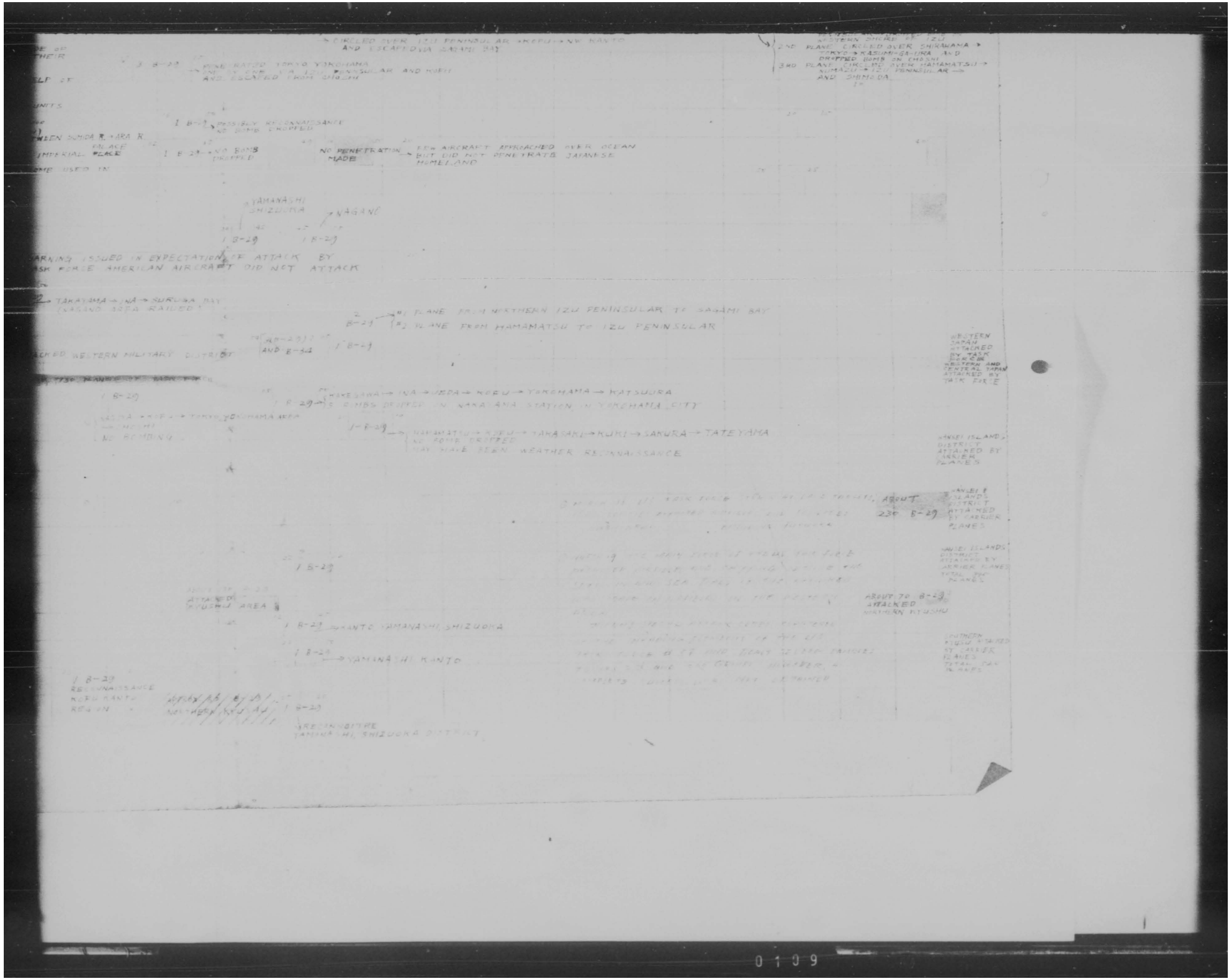


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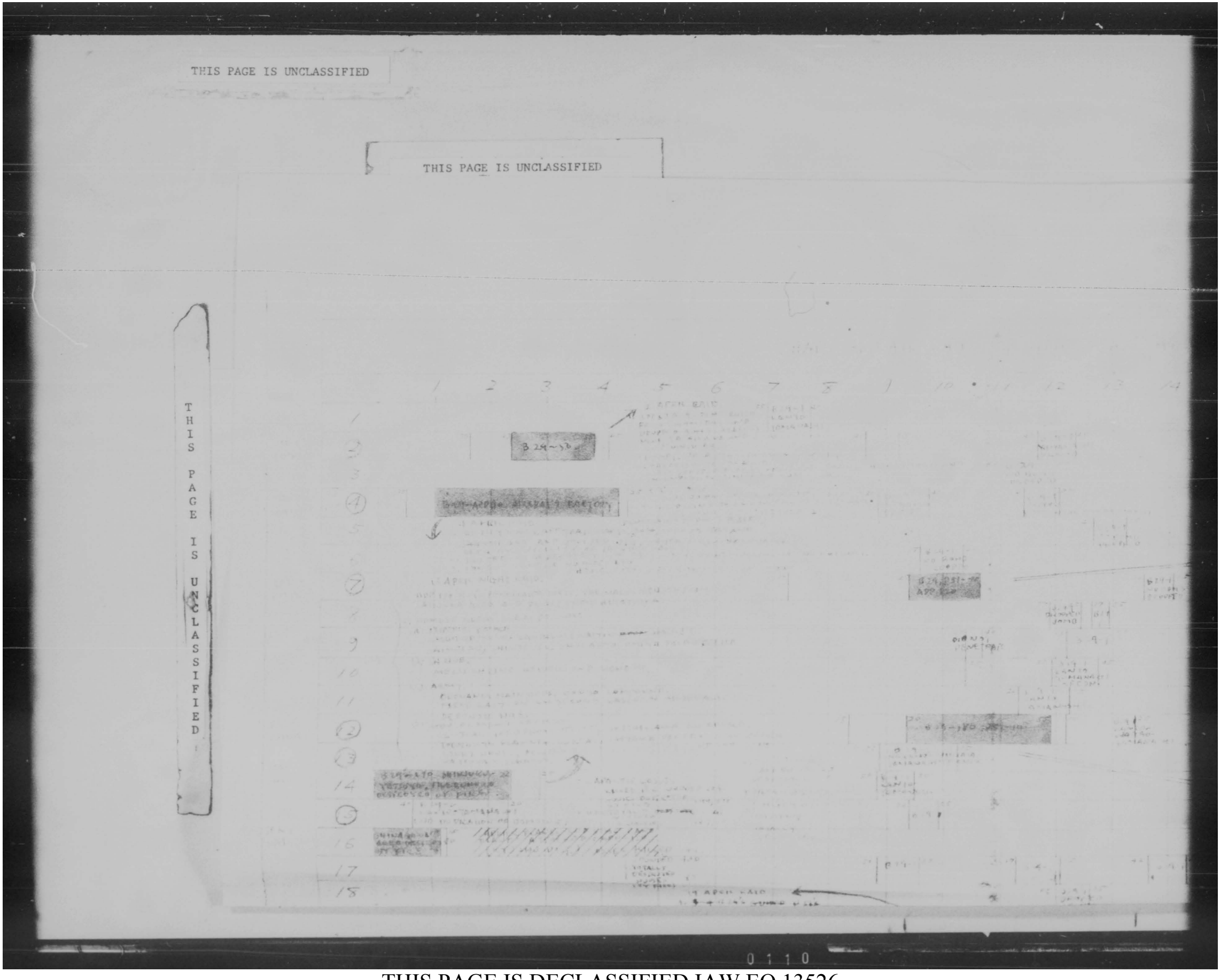

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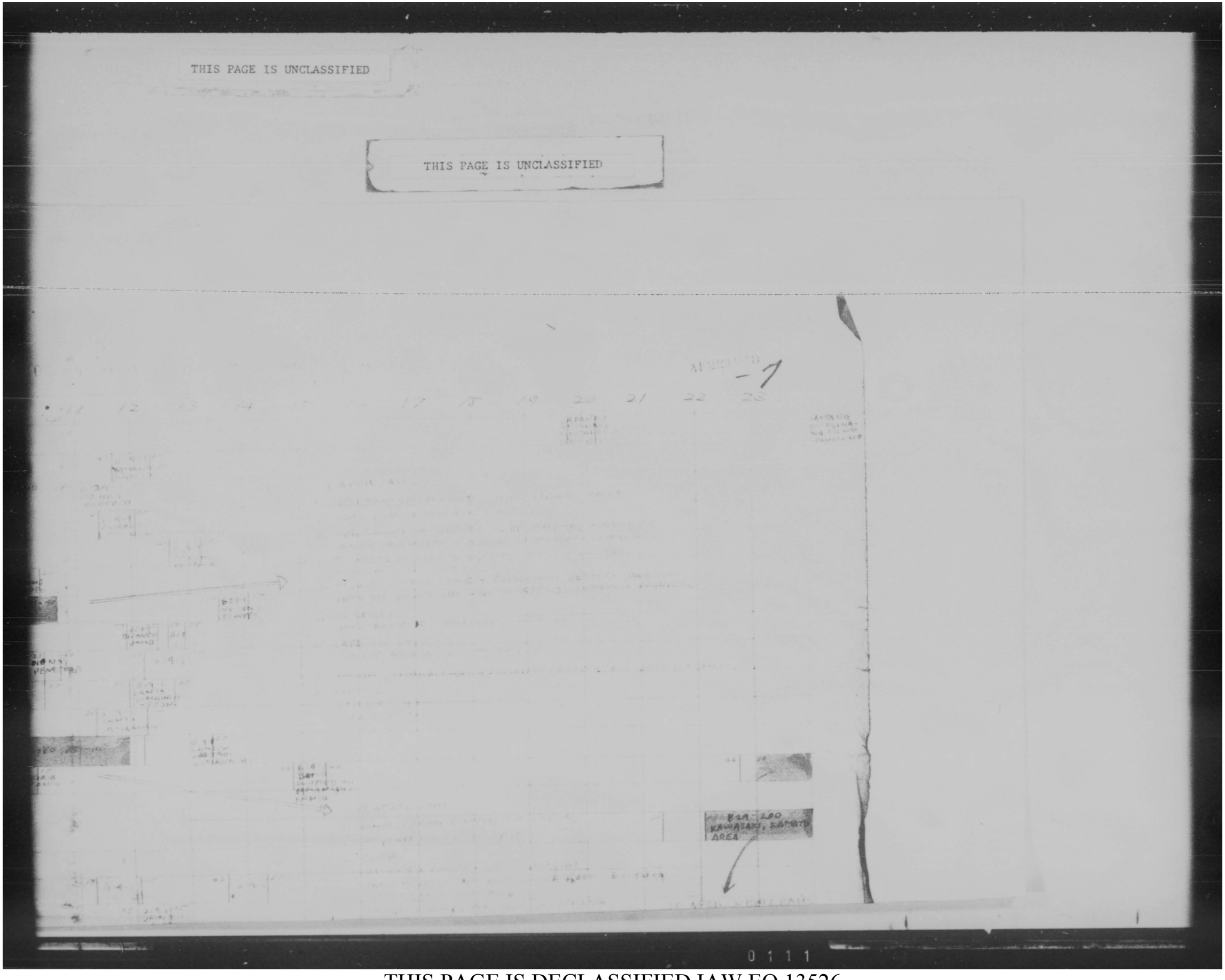


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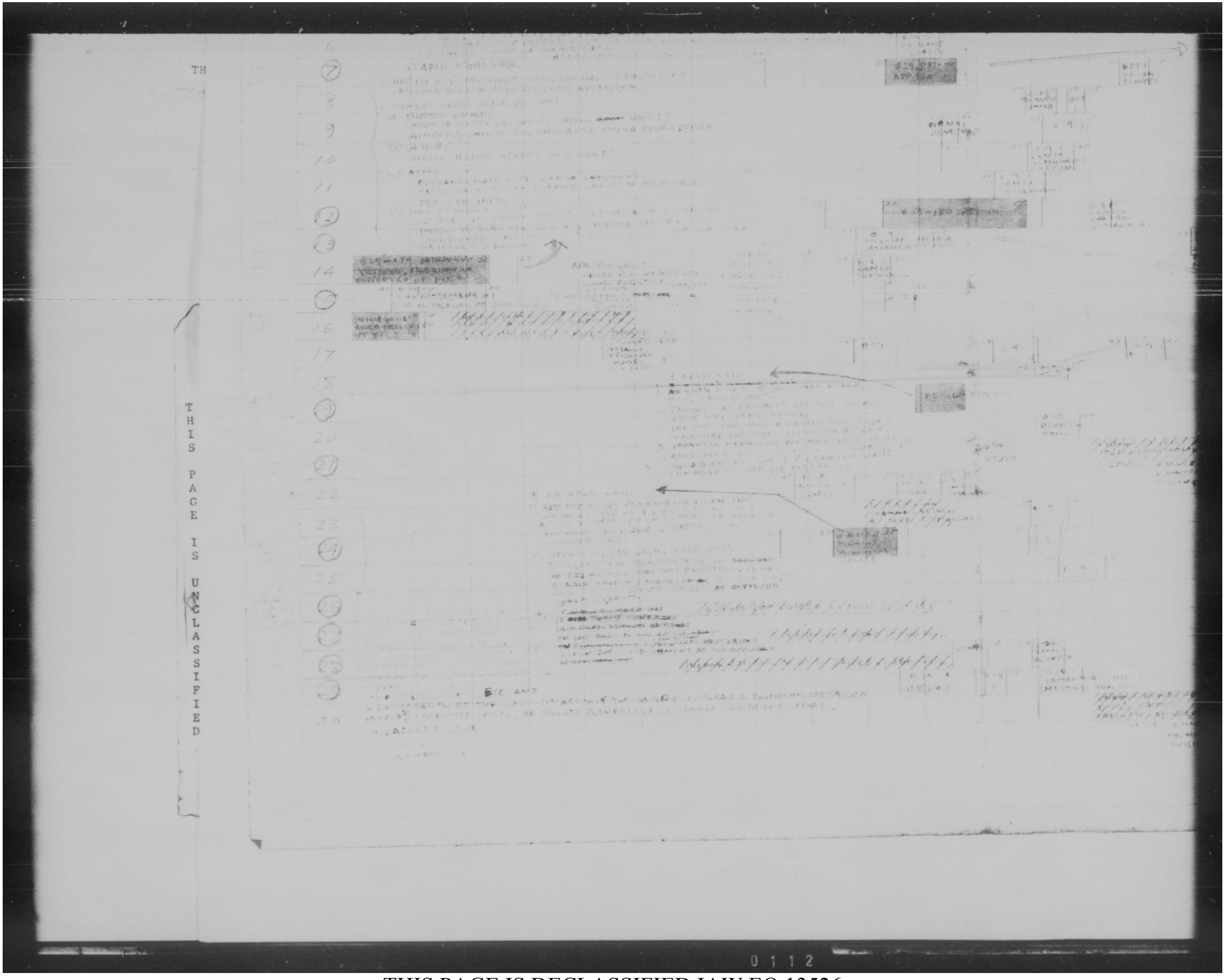


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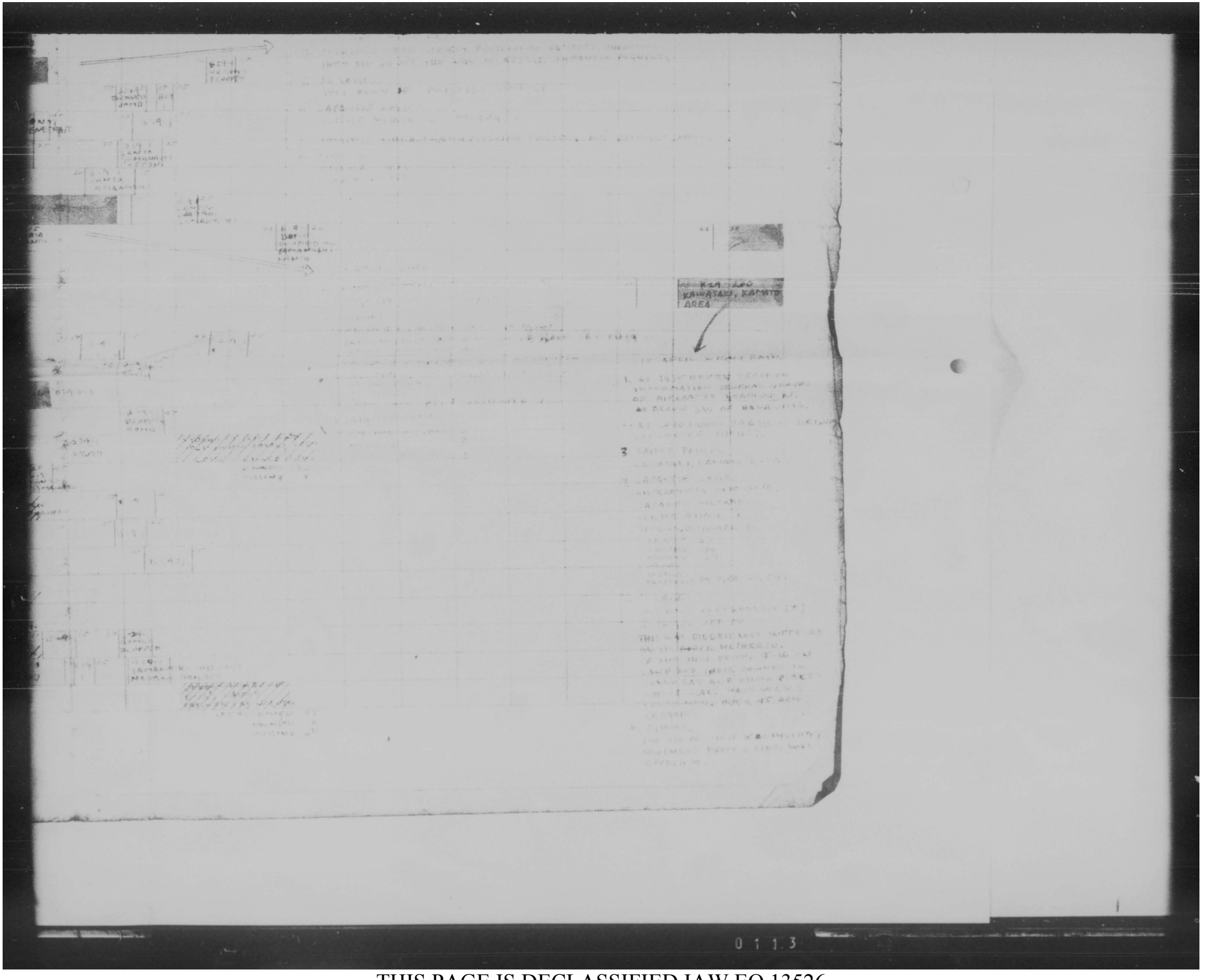


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CHART OF AIR RAIDS BY AM

HOUR
DAY

1 2 3 4 5 6 7 8 9 10 11 12 13

TOKYO

KANTO
YAMANASHI-NIIGATA
DIST.

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SUPPLEMENT 1 OF 10 ARTIA

RT OF AIR RAIDS BY AMERICAN AIRCRAFTS (MAY 1945)

AD221-30 -8

9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

1029 YAMANASHI

1049 YAMANASHI

YAMANASHI KANTO



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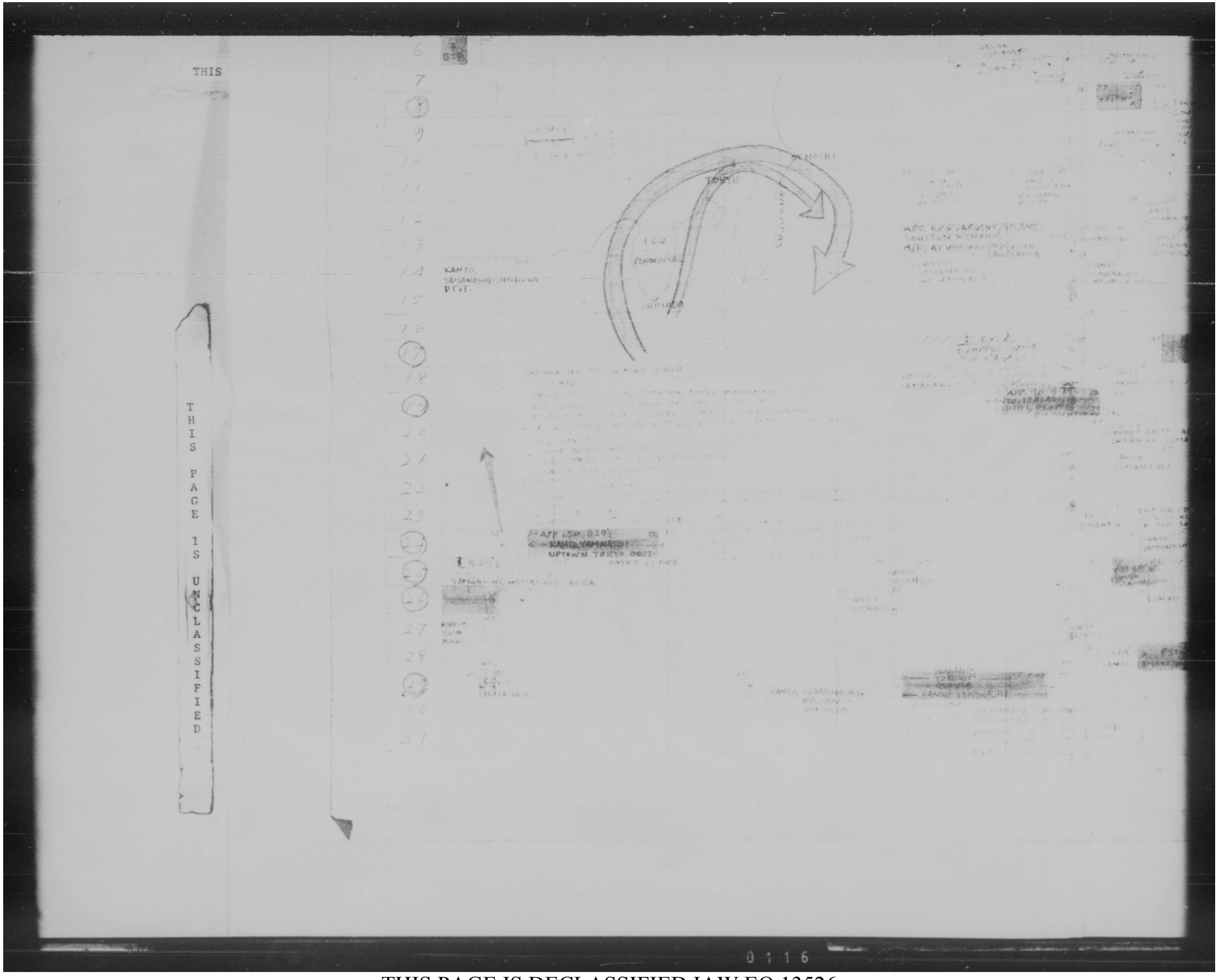


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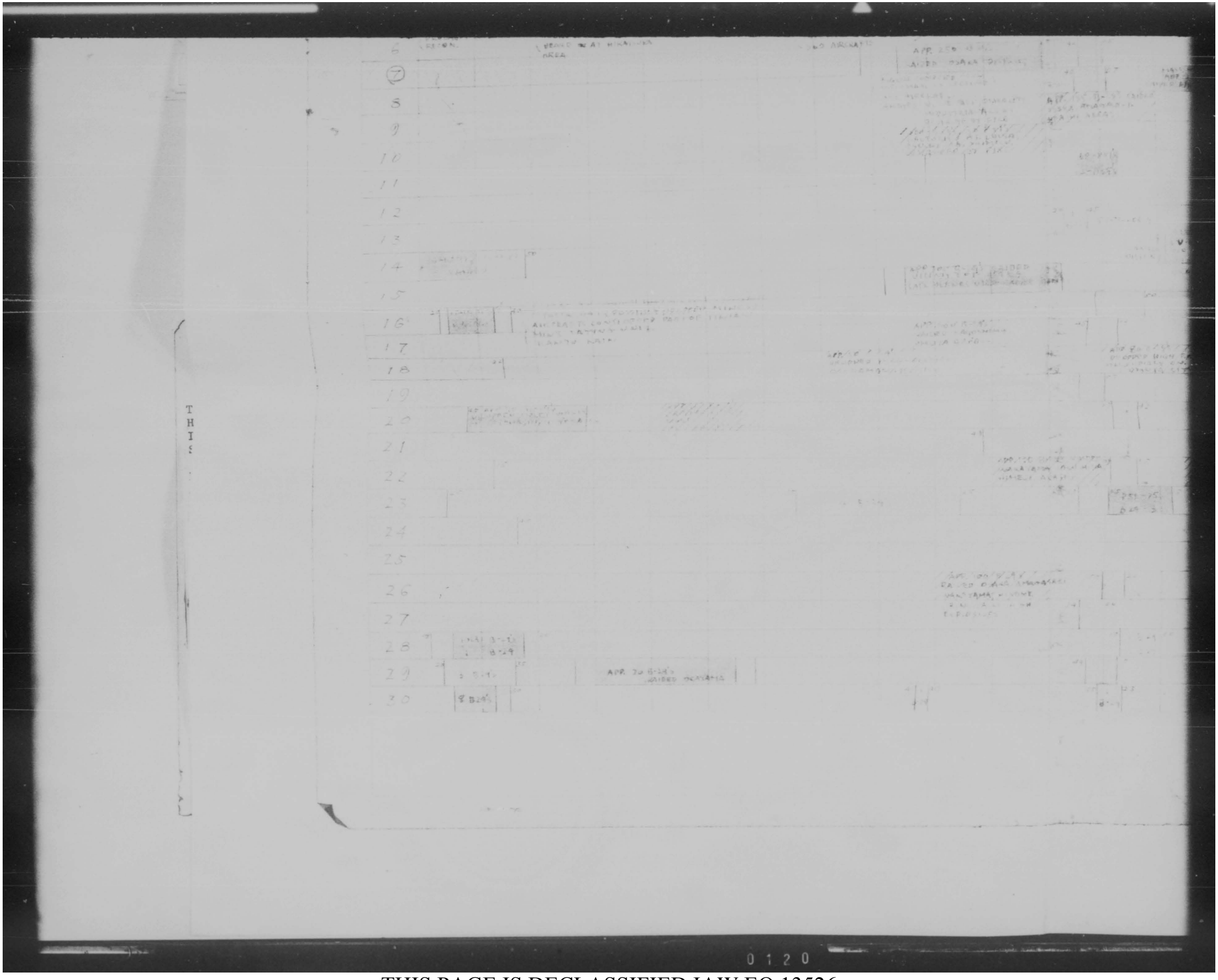



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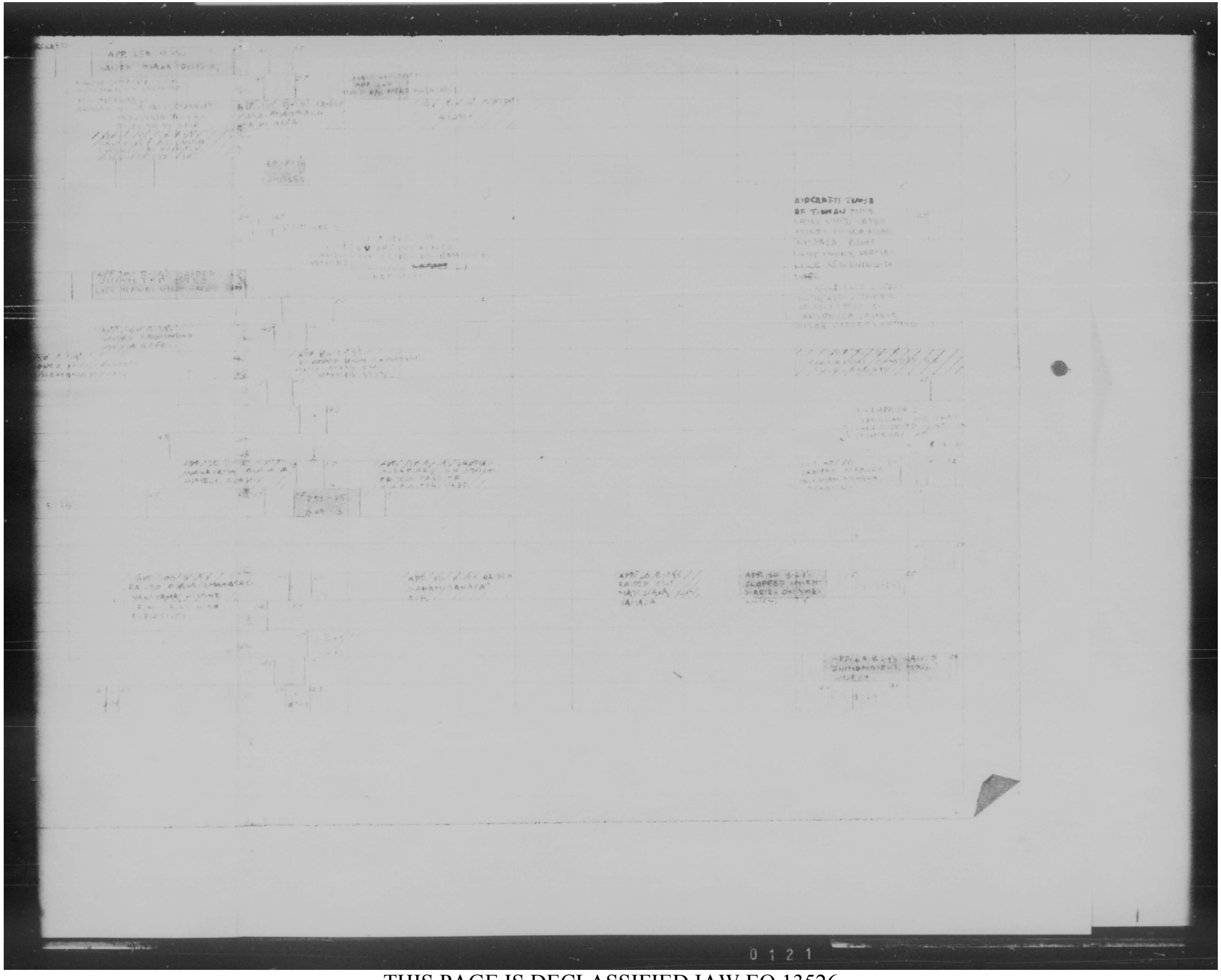



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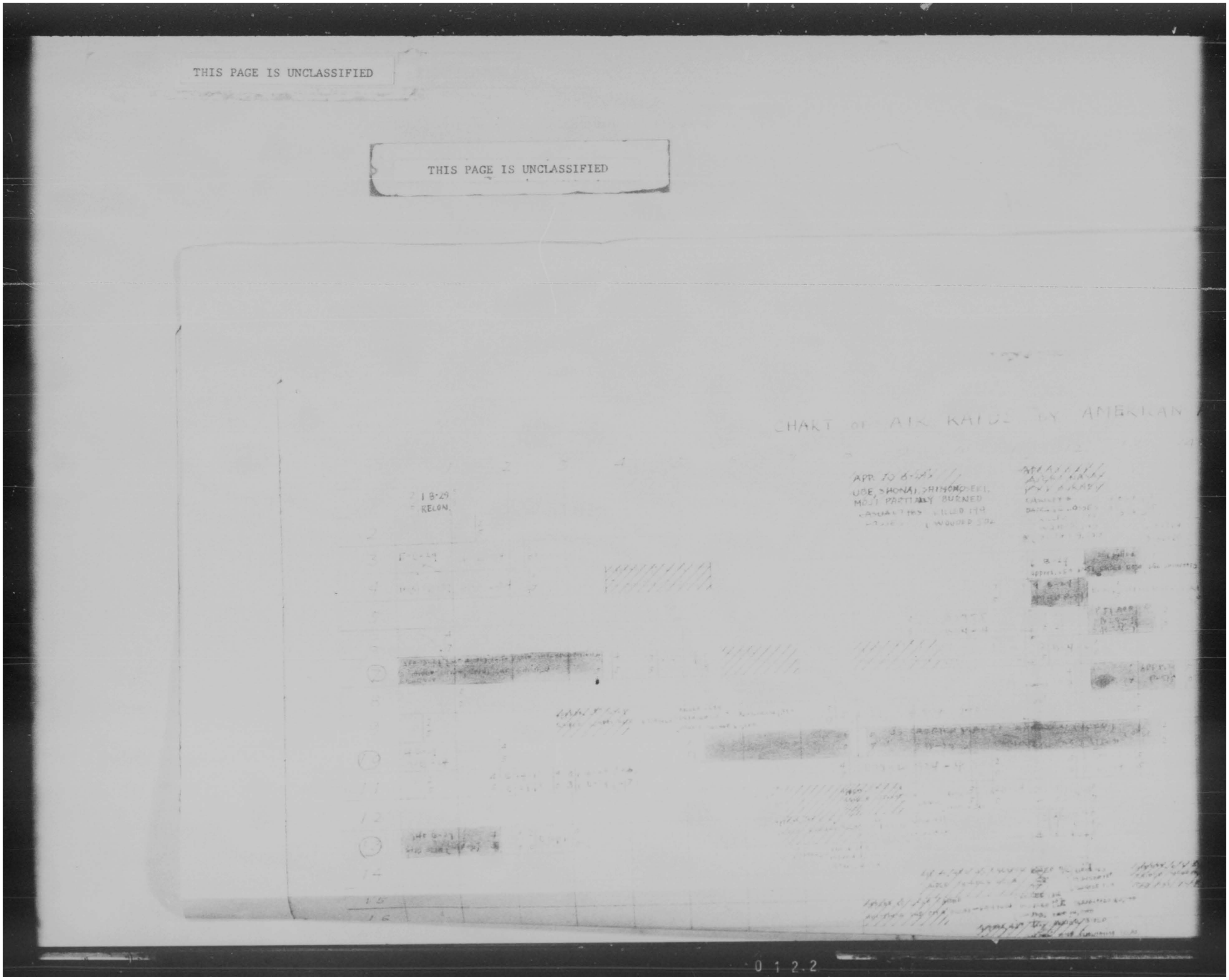


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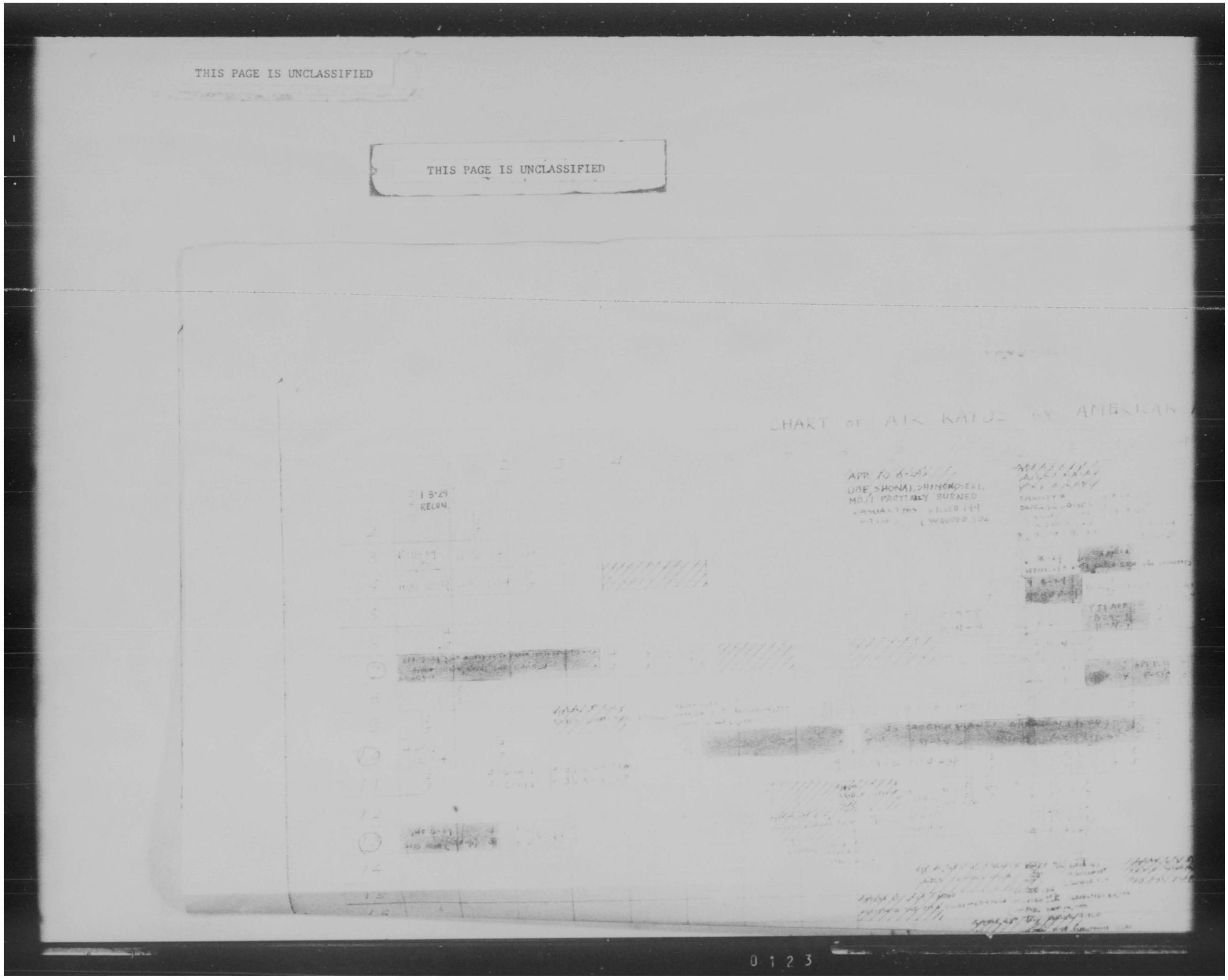


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SUPPLEMENT 9 OF 10 AKIIA

OF AIR RAID BY AMERICAN AIRCRAFT (JULY 1945)

-10

APP TO B-29's
(UBE, SHONAI, SHIMONOSEKI, MOJI PARTIALLY BURNED
CASUALTIES KILLED 199
WOUNDED 502

APP 60 B-29's
KUMAMOTO CITY AREA



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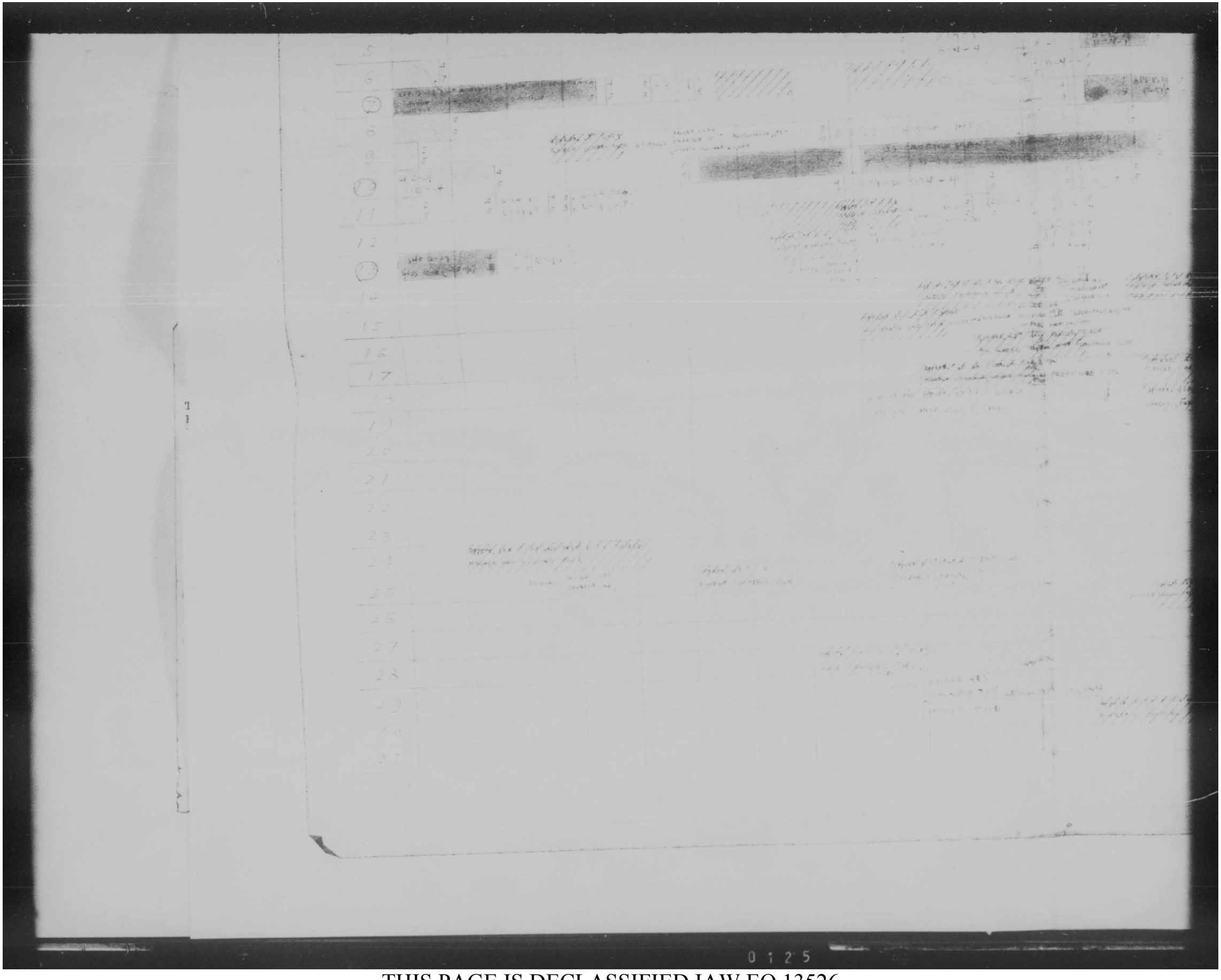

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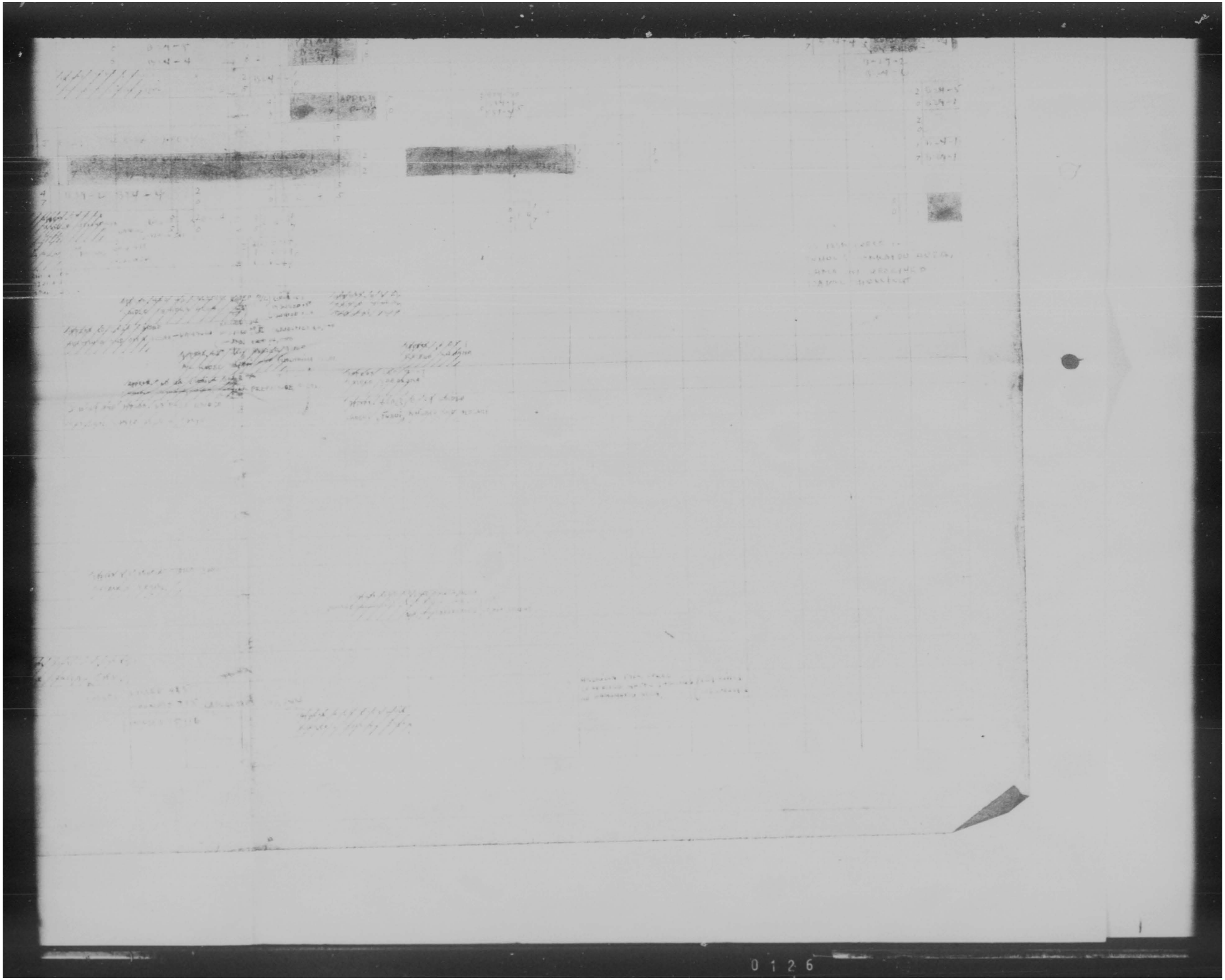



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# CHART OF AIR RAIDS BY AMERICAN AIRC

KANTO RAID

BOMB, DROPPED ON CHOSHI, TOYAMA. KISARAZU, (US B-29 1 CRASHED AT KISARAZU)

DETACHED FORCE 7 OTHER THAN ABOVE 359 BASE RAIDED TSURUMI, TACHIKAWA AREA

STRIKE BY APP 130 P-51'S UTSUNOMIYA TACHIKAWA AIR BASES ATTACKED

APP 60 P-51'S

ATOMIC BOMB ON HIROSHIMA

APP 130 P-51'S ATTACKED AREA

ATOMIC BOMB DROPPED ON HIROSHIMA

APP AB B'S TOKYO-YOKOHAMA DISTRICTS

APP 85 B-29'S TOYOKAWA NAVAL ARSENAL YARD

P-51 APP. 70 CHUBU NAGOYA AREA

APP 280 B-29'S N. KYUSHU, YAWATA STEEL WORKS

ATOMIC BOMB ON NAGASAKI

APP 20 CARRIER PLANES ATTACKED TOHOKU MILITARY DIST. AND PART OF IT ATTACKED NIIGATA DIST.

CARRIER PLANES TOTAL 1,700 IN TOKYO DISTRICTS

APP 90 B-29'S & 50 P-51'S IN TOKYO KILLED 50 WOUNDED 89

APP 45 CARRIER PLANES

APP 35 CARRIER PLANES

ATOMIC BOMB DROPPED ON NAGASAKI

AGGREGATED TOTAL FOR 13TH, 14TH & 15TH

B-29 P-51 1235 ATTACKED VARIOUS AREA AND HONMAIDO

DAMAGE KILLED WOUNDED

US CARRIER PLANES AND B-29S ATTACHED CHIBA TOKYO AREA SOME OF THEM DROPPED COPIES OF THE INSTRUMENT OF SURRENDER

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SUPPLEMENT 10 OF 10 (ARITA)

# AIR RAIDS BY AMERICAN AIRCRAFT (AUGUST 1945)

APP 450 B-29'S
YOKOHAMA, TSURUMI, KAWASAKI, NAGAOKA, HACHIOJI, TACHIKAWA
→ DAMAGES KILLED 406
BADLY WOUNDED 2,000
HOUSE COMPLETELY BURNED 9,000

STRIKE BY APP 100 P-51'S
UTSUNOMIYA TSUCHIURA AIR BASES ATTACKED

APP 68 P-51'S

APP 417 B-29'S
DROPPED BOMBS ON
MAEBASHI, TAKASAKI, CHOSHI
→ DAMAGES
KILLED 673
BADLY WOUNDED 2,828

ATOMIC BOMB DROPPED ON HIROSHIMA

APP 45 P-51'S
TOKYO-YOKOHAMA DISTRICTS

APP 85 B-29'S KILLED 600 WOUNDED 700
TOYOKAWA NAVAL ARSENAL YARD

P-51 APP. 70
CHUBU NAGOYA AIR

APP 280 B-29'S
KYUSHU, YAWATA STEEL WORKS

APP 65 B-29'S
FUKUYAMA AREA

USSR DECLARED WAR ON JAPAN

USSR JOINED THE WAR

CARRIER PLANES TOTAL 1,700
ON TOKYO DISTRICTS
WOUNDED 2,000

APP 44 CARRIER PLANES

APP 35 CARRIER PLANES

ATOMIC BOMB DROPPED ON NAGASAKI

AGGREGATED TOTAL FOR 10TH (A TH & 15TH
B-29
P-51 } 1235 ATTACKED VARIOUS AREA AND HOKKAIDO

DAMAGE
KILLED 2526
WOUNDED 2,840

IMPERIAL RESCRIPT ON THE TERMINATION OF HOSTILITIES ISSUED

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HIROSIMA

ATOMIC BOMB DROPPED ON HIROSHIMA

APP 45 B-29'S TOKYO-YOKOHAMA DISTRICTS

APP 85 B-29'S TOYOKAWA NAVAL ARSENAL YARD

P-51 APP 70 CHUBU NAGOYA AREA

APP 200 B-29'S N. KYUSHU, YAWATA STEEL WORKS

ATOMIC BOMB ON NAGASAKI

APP 20 CARRIER PLANES ATTACKED TOHOKU MILITARY DIST. AND PART OF IT ATTACKED NIIGATA DIST.

CARRIER PLANES TOTAL 1,700 NW TOKYO DISTRICTS

APP 90 B-29'S & 50 P-51'S NW TOKYO KILLED 50 WOUNDED 89

APP 44 CARRIER PLANES

APP 35 CARRIER PLANES

ATOMIC BOMB DROPPED ON NAGASAKI

AGGREGATED TOTAL FOR THE 14TH & 15TH

B-29 / P-51 1235

DAMAGE KILLED WOUNDED

ATTACKED VARIOUS AREA AND HONKAIDO

US CARRIER PLANES AND B-29'S ATTACKED CHIBA TOKYO AREA SOME OF THEM DROPPED COPIES OF THE INSTRUMENT OF SURRENDER

STUDENT OF JUNIOR ARMY CADET SCHOOL OCCUPIED BROADCASTING STATION NEAR KAWAGUCHI

ADVANCED ECHLON OF US AIR TRANSPORT UNIT ARRIVED AT ATSUGI A/F

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APP 45 B-29'S
TOKYO-YOKOHAMA
DISTRICTS

APP 85 B-29'S
TOYOKAWA NAVAL
ARSENAL YARD

KILLED 600
WOUNDED 700

APP 280 B-29'S
N. KYUSHU, YAWATA
STEEL WORKS

APP 65 B-29'S
FUKUYAMA AREA

KILLED 673
BADLY WOUNDED 2,828

A-51 APP. 70
CHUBU NAGOYA AREA

CARRIER PLANES TOTAL 1,700
IN TOKYO DISTRICTS

WOUNDED 2,300

USSR
DECLARED
WAR ON
JAPAN

USSR
JOINED
THE WAR

APP 44
CARRIER
PLANES

APP 35
CARRIER
PLANES

BOMB DROPPED
ASAMI

DAMAGE
KILLED 2526
WOUNDED 2,840

AL FOR 13TH 14TH & 15TH
ATTACKED TARGET
AREA AND HOKKAIDO

IMPERIAL RESCRIPT
ON THE TERMINATION
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ADCASTING STATION NEAR KAWAGUCHI

GEN. TANAKA
KILLED HIMSELF

CHLON OF US AIR TRANSPORT UNIT
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*Narrative History of 497th Bombardment Group

1. The First Bivouac

After setting foot on land, personnel making up the 497th Group, were loaded onto trucks and whisked off to the area assigned to them. The route lay thru the broken town og Garapan. This town was reputed to have a pre-war population of nearly 10,000 persons, and was easily the largest town on Saipan. It now was a mere mass of rubble, and everyone got a close-up view of the destruction resulting from our invasion.

The remainder of the ride, seemed to be through green fields, and exhibited little evidence of the bitter fighting that had taken place only a few months previously. The ride left a confused impression, of a sultry, damp climate, surprisingly good roads near the harbor; atrociously bad ones in outlying districts; nearly obliterated buildings in the towns but little other evidence of damage elsewhere; lots of activity; a general impression of hustle and a tremendous amount of construction activity.

After a ride of nearly an hour, which took that length of time however, mainly because of the muddy paths the trucks had to follow, the convoy halted beside a sugar-can field. The scene was very attractive. A vast expanse of sea lay below, with a number of cumulus clouds floating over a mass of white caps kicked up by a strong breeze. It was a very enjoyable sight.

Everyone was rudely interrupted from their staring by a voice telling them to climb down because this was their destination. The sense of pleasure being experienced by all quickly vanished. Destination? Why this was only a partly cleared, muddy sugar-cane field. It must mean that tents will have to be pitched, and quickly too, because it was already late afternoon.

It was a rather surprised group that piled out of the trucks. Very few, if any, had given much thought as to what conditions would be on shore. Everyone had been so anxious to get off the hated FAIRISLE, that they had assumed that everything on shore would be far better. Naturally, then, they were somewhat startled to find that those rosy dreams were not true. They were going to live in pup-tents and like it. All now realized the import of what Colonel Wright had reminded them before they departed from Pratt, namely, that a B-29 man was no different than anybody else, and that each officer and enlisted man in the advance echelon could consider himself as a 590. So each man sighed as he jumped down from his truck. It looked like things were going to be tough for a while.

And tough they were, as every man started in to pitch shelter-halves on the damp, uneven ground. To many the art of bivouac had been just another chore to complete, as part of a training program. Some of it had been fun, and part of it an annoyance. But, to most, it had been nothing serious. They would never really have to do anything like that. Yet here they were, and it was quite serious. There was no play or fun involved.

*Narrative History of 497th Bombardment Group, 73rd Wing, XXI Bomber Command, Twentieth Air Force, Period: 16 Sept. to 31 Oct., 1944 (Ground Echelon).

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The next chronological event in these men's lives, was a slight hiatus in tent pitching, while evening chow was consumed. But is wasn't the usual chow to which all were accustomed. It consisted exclusively of K rations. This was the first taste of such rations for most personnel, and it was not bad either. In fact it tasted pretty good. It can be officially recorded that K rations were found perfectly adequate and satisfying. Cold C rations however, were later found to be unpalatable.

Probably considerable space could be readily devoted to the events of the first night! It was of intense personal interest to all concerned, but nothing of real historical importance occurred. It can safely be averred, however, that green troops placed in the vicinity of the unknown, can be very nervous indeed. While on shipboard, many tales had been told concerning the large number of Japs on the Island, who roam around at night, slitting throats and holding pitched battles with American patrols. Were the reports true? Nobody knew for certain, but some observant souls, had noticed that a number of soldiers on the Island carrying carbines. So maybe the stories were true. It will suffice to say that the first night found the 497th a tired, somewhat stunned, and uneasy organization. The guards hurriedly summoned, and posted just as the early darkness blanketed the Island, really had the most difficult time. They were in inky blackness, on strange posts, surrounded by high bushes, and they knew not what else. The remainder went to sleep, but slumbered fitfully. The hard ground, was worse than the oft-cursed bunks of the FAIRISLE.

The morning dawned clear, and it was soon ascertained that morale had survived the first night in good shape. Many a call was hear, as a man stuck his head out of a pup-tent, to the effect that "Blackout is now over. You may now smoke on the open deck". This echoed the familiar call that boomed over the speaker-system of the FAIRISLE every morning and awakened all personnel. It was a cheery greeting to the new day, and showed that everyone had come through the first trying night in good shape.

The next day was spent in getting acquainted with surroundings, and putting the camp in order. The 870th and 871st Squadrons had not reached their bivouac area until weel after dark, and had pitched their tents under difficult conditions. Such problems as food, water, sanitation, details of all sorts were of first importance, and reliance had to be placed on the 65th Service Group, which had been assigned to work with the 497th Group. Unloading the equipment on the boat was also of high priority, and a dump was soon established, which however, included property of all the units that came over on the boat. These general matters occupied everyone's attention the first day.

During the next night, the organization discovered one of the principal features of the Island of Saipan - rain. About midnight, a torrential rain fell. This was really nothing new because there had been showers off and on during the preceding 36 hours. However the one in question seemed to be a shower to end all showers. It poured; the wind blew, and everybody suffered, more or less silently, while the water seeped in on those unwary souls who had not ditched their tents very carefully. It was a bad night for all. Yet at daybreak, the same cries as to blackout being over, again

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resounded thru the area, indicating that morale was good. Morale remained good during the remainder of the period covered by this installment, despite the numerous hardships referred to.

Another difficulty encountered was that of locating TAT and QM equipment unloaded from the boat. The Island Command put a time limit on the period for unloading. At the end of that period, the ship would have to leave the dock area, and proceed to a point away from shore, and could be unloaded there only by means of small lighters. Thus speed in unloading became very important. There was no time to sort property as it was unloaded. Everything belonging to all of the various units who came out on the boat, was unloaded as quickly as possible, and placed in one common dump, located at a place centrally located to all the units. Thus it soon became a near-impossible job to locate equipment as the pile increased, and much needed equipment could not be found until after a search of several days.

Colonel Campbell, after disposing of a multitude of preliminary matters turned his attention towards the main objective - the creation of the permanent camp. Island engineers had prepared a blue-print showing the location and general set-up.

The proposed site lay along the edge of a Strait that was between Saipan and Tinian, about a mile from the bivouac area. That, of course, was unobjectionable. It provided a pretty setting, with sheer cliffs to the rear, and the blue sea in front. It was however, the condition of the site, and the access thereto, which were discouraging. Taking the latter first, it must be pointed out that the only access was by means of a narrow dirt and rock, one-width cartway which ran along the top of the afore-mentioned cliffs and then abruptly descended to the fields which were to be the site of the permanent bivouac area. It was not a street. It wasn't even a road. It can be best described as a cartway, probably used for horse-drawn native vehicles.

Butit was the site itself that gave the most concern. It was for the most part, an immense field of sugar-cane. Of course that in itself was not so cataclysmic but the fact that the Group personnel themselves, and themselves along, would have to cut it down so that the site could be properly prepared for building, was the most startling factor. Yet there was no other unit which was going to clear the site, so the decision to commence work as soon as possible, was made.

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* Narrative History of 497th Bombardment Group

2. Preparation of the Permanent Area

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The first problems encountered here, was how to cut down the cane, underbrush and other growths which were on the site to be used. The equipment belonging to the Group was totally unsuited for that sort of owrk. There was no bull dozer for clearing and leveling. There were no scythes for cutting. There was no suitable heavy equipment at all.

The natural thing them to do, was to call upon the Service Group. This was to no avail. The 65th Service Group, which had arrived on the Island, some 10 days prior to the Group, and which had likewise settled in a temporary bivouac Area, was at the same time engaged in preparing its permanent area. All the heavy equipment it possessed was being used to clear this area. Hence there was no choice but for the Group to attempt to clear the area with whatever hand tools it had. Thus a lesson could well be learned relative to future operations. A Service Group and a Tactical Bomb Group should never be sent into an area where both have to simultaneously clear their respective area. There is not sufficient heavy equipment between them to do the work expeditiously, and the Tactical Group will naturally suffer thereby.

Before the clearing work commenced however, an additional problem arose. Was the Area safe? The Island G-2 section had informed the Group S-2 section that there probably were no Japs in that section though there might be a few odd civilians hiding in caves, who would offer no violence. But considerable shelling had taken place near Nafutan Point, [Saipan] near the Group area. One land-mine had been found on the edge of the temporary bivouac area. There might well be a number of casualties if a large group of men were put to clearing the permanent area, should there prove to be a number of live shells, or mines or dud hidden by the sugar cane and brush.

Since no assistance was available from other sources on the Island it obviously was to be the responsibility of Group personnel to handle this job too. Fortunately all ordnance personnel were in the Ground Echelon, so they were organized into a Bomb Reconnaissance Squad. To save time the following procedure was established. The reconnaissance squad would start at one end of the area, and would thoroughly cover a strip of land. If anything was found, that area in which it lay was marked off, and the Island Bomb Disposal unit notified. The men who were to clear the area, would follow the reconnaissance group along, and cut down and clear the area which had been searched and found safe. Then in due course, when the Island Bomb Disposal unit removed the unexploded shell or whatever object was found, that section was cleared by the Group personnel also.

This all proved to be a slow process. The miserable cartway leading to the permanent area, made it difficult to transport personnel to and from the Area. Most of the men had to walk the mile to and back from the area. This was rather hard on them, because the sun was very hot, and the work back breaking. Clearing the large area, by men using any form of

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hand-tool available was slow and arduous work, and was wasteful of men and time, although nothing different could have been done.

During all this time, personnel were still living in pup-tents and eating cold K and C rations. Incessant rains, in heavy shower form would pour down constantly, with the result that anumber of the men were catching cold. So the Commanding Officer was faced with the problem of moving into the half-cleared area, and establishing living quarters in pyramidal tents, or waiting until the whole area was ready and then move, but in the meantime keeping the men living on the muddy ground. A move at this point, meant an additional move later on when the various Squadron Areas were cleared.

Colonel Campbell decided that the best thing to do was to move down to the site as soon as possible. But there was still one problem to be faced - sanitation. In the temporary area, slit trenches of various sorts had been built. In the permanent area, permanent latrines were planned. These, however, had to be blasted, because the soil of Saipan was merely a slight cover over a base of jagged coral rock. The progress along these lines was slow, because there was no equipment in the Group T/E, which was suitable for blasting. There were no jackhammers; no dynamite and no apparatus for removing rock from the blasted holes - some of which were to go to a depth of 15 feet. Whatever equipment the Service Group had, it was using itself, again proving that the Service Group should be fully set up before the Tactical Groups arrive. Finally a jack hammer was borrowed from one of the Engineer units on the Island. However it was obtainable only for night use, since the Engineers needed it during the day. Thus the work progresses slowly.

Colonel Campbell still felt that it was important to move down to the permanent area. He therefore ordered that the work of blasting latrines, be concentrated in one location, so that there would be proper sanitation, and the troops moved into that location. This was done, and a portion of the area assigned to the 869th Squadron was soon ready. The order to move was then given.

Very little space has been given to the blasting of the latrines. The pictorial section of this history will show the problem in greater detail. Too much credit cannot be given to the personnel who worked nightly on that detail for a seemingly endless time. The blasting continued throughout the period covered by the next section of that history. The cry "Fire in the Hole", became a by-word throughout the Area. Many a tent saw a rock go through it, and several personnel were hit by flying fragments. Bomb-trucks were used to hoist the debris from the hole, and lack of tools required that the men pile broken coral, by hand, into empty oil drums, and it was then hoisted to the surface by the bomb truck. It was effective, but very primitive and wasteful.

3. The Move to the Permanent Area.

This was accomplished without incident. As soon as Colonel Campbell determined that latrines were sufficiently blasted within the area where intended to establish a temporary camp, and that the area was sufficiently cleared, and was safe, he gave the order to move. All available trucks were



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were pressed into action, and the whole move accomplished in one day. The old gypsy camp was struck. The men hurriedly packed their equipment, and were loaded into trucks which bounced down the miserable road towards the permanent area. For a time it looked as tho' everybody might not be able to move during the daylight hours. As darkness came, Group Headquarters personnel were still awaiting their turn, and it did not appear that they would be able to move before complete darkness. Colonel Campbell decided, however, that for security reasons, he strongly desired all personnel at one location. Hence efforts were redoubled, and just as darkness settled completely, Headquarters reached the new location. This took place on September 23, 7 days after arrival at Saipan.

The Area into which the organization moved, composed about 3/4 of that allocated to the 869th Squadron. Pyramidal tents had been erected for all personnel, and the move meant the end of pup tents, and enabled all to use cots. It meant that everyone was now located in the permanent bivouac area, and that the daily problem of transporting personnel from one area to the other need no longer be reckoned with.

4. Construction Problems in the Permanent Area.

An attempt has been made in the pictorial section of this History, to show the progress of construction and development of the camp area. In this portion of the History, and attempt will be made to discuss some of the problems involved in the building of the permanent camp.

It can be safely averred that a considerable portion of the training of the Ground Echelon had been misdirected. Each man had been given some training in the specialty in which he worked. Actually some, in fact considerable training should have been given in carpentry, blasting, bivouac problems, surveying, quonset hut construction, and allied matters, because, it was in those fields that the main work of the Ground Echelon was to be directed for the first 30 to 45 days after landing. Several courses in the use of the various standard tools would have been helpful. Specialties meant absolutely nothing at this stage of the work.

There was no one main problem at this point. Rather there were a number of problems and the difficult job was to tie them all in. Among such problems were: the blasting of the latrines; the lack of lumber for tent floors; the heavy rains which made the access road all but impassable the lack of nails; the lack of heavy equipment and the concentration of personnel and traffic in a small area, with the resultant churning up of that area.

The whole problem was fundamentally an engineering and construction one. Colonel Campbell approached it from that standpoint. He decided that pending final completion of the job, that the Squadrons would have to lose their identities, and the job tackled on a Group basis. The Colonel appointed Major Leer in charge of construction, with full authority to work on any particular Squadron area, and on any particular part thereof depending upon what materials were ready. He assured the Squadrons that while their men might be working on an area belonging to a different Squadron Area would be completed before another.

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All officers and enlisted men were told that they would not be working in their specialties; that they were al 590's, and that their main job was to get the area complete and the housing built. In line with this decision, was the appointment of various officers to be in charge of some of the various important phases of the work. Procurement of lumber, and in charge of all transportation was placed on the shoulders of Lt. Conners of Group Hq. Lt. Peterson of the 869th, was put in charge of tent-flooring, and erection. Latrine construction became the job of Capt. Brown of Group Hq., and so on. Every night an officers call was held, at which all the days problems were discussed, and the plans for the next day laid out.

Thus, day by day, construction progressed, at a surprisingly rapid clip. At one point, the Group was congratulated by Colonel Brugge, Commanding Officer of the Wing Advance Echelon, as being far ahead of the other Groups. This, Colonel Campbell, believes was due to these set of rules: 1. Figure out as far in advance as possible, all priorities. 2. Do all blasting work before moving into an Area. 3. Drop all Squadron identities, and work as a Group, although after the big jobs have been done, turn them back to the Squadrons, in order to develop Squadron initiative. 4. Sacrifice comfort, and bivouac temporarily, so that progress can be made unhampered in the permanent area. 5. Have an officers call at the close of the day, to plan tomorrow's work. 6. When equipment must be borrowed, delay requesting it until there are a number of uses for it, so that maximum use of such equipment can be made. 7. The Ground Echelon should sacrifice its own comforts and frills, until living quarters for the Air and Flight Echelons were well advanced.

A detailing of the day by day progress of the work, or of any part of the work would serve no useful purpose. It need only be noted that at first it seemed to go very slowly. This, of course, was due to the fact that most of the work consisted of ground work - laying foundations - tent floors - completing latrines - laying wires etc. However, when the girders of the quonset huts started to appear above the ground, then morale was heightened, and all could see what being accomplished from day to day.

The whole period was characterized as a battle for equipment. Many a scavenging party was sent out to find almost any article ranging from nails to water-tanks, and nearly everyone returned with booty of some sort. A bit of Group rivalry sprang up, and at one point Colonel Brugge was forced to issue an order that any individual borrowing or appropriating property or equipment from one of the other units in the Wing, would be court-martialled.

The work progressed, however, without it being necessary to evoke that rule. The 871st Squadron put up 14 quonset huts in 14 days. They and the 869th Squadron used teams of specialists, who did just a certain bit of work, and moved from building to building. The 870th used one team to construct each quonset, but this system proved to be just a bit slower.

Morale, during this period, reached its height, when on Oct. 12, the first B-29 appeared over Saipan. It's arrival had been predicted, and as

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it appeared overhead, escorted by fighters, a great cheer went up, and all work stopped as men shaded their eyes to watch the plane pass overhead. There was some hope that it might even be a plane of the Group. However it turned out to be one from the 498th Group piloted by General Hansell. But the thrill that went through all was almost electric in effect. The sweating GI's who had constructed quonsets dressed only in bathing trunks, and who worked right through the extremely heavy showers that blew up on an average of three or four a day, blotting out the landscape, now realized that the time for their contribution to the war effort had arrived, and morale, attitude and industry improved accordingly.

5. Captives Taken

The importance of taking two prisoners on Saipan is not great, when compared with other accomplishments of the Advance Echelon. However, your Historian believes that it is very rare for ground echelons in the Air Corps to take prisoners. He further believes that this was the first instance of any B-29 unit engaging in such activity, and therefore had prepared this separate section covering the incidents.

The first captive was taken on October 4th.[1] On that day, three enlisted men from the 870th Squadron, to wit; S/Sgt. Frank Veselovsky, Cpl. Per A. Edholm and Pfc. Regis J. Gully were out on a scavenger hunt for some machine parts. Their quest took them to the northern portion of the Island. At this point it should be made clear, that the northern half of the Island was "off limits". A surprisingly large number of Japs remained on the Island at this period. They had mostly been herded into sections in the north part, where they had organized into small groups. A number of island personnel had been killed or wounded souvenir-hunting in areas near where these Japs were holed up in various caves.

It is not the function of your Historian to discuss the possible rights of the men to be where they were. Actually, they had permitted their jeep to wander up a road which was in the off-limit sector, and which, it was later ascertained, was unusually dangerous. While on foot, they came around a large rock, and lo and behond they came upon a Jap, literally with his pants down. (He explained later that he had dysentery). As soon as the Jap recovered from his surprise, he started to reach inside his coveralls for a grenade which he was carrying. But realizing that he was covered by three guns, he quickly desisted, and glumly surrendered. The scavenger hunt had ended and the three men hurried back to the bivouac area, with their unexpected prize.

The wildest excitement raged through the camp area, and the camera fiends tried to snap many pictures of the captive. The presence of the prisoner was reported to the Island Provost Marshall, who requested that he be brought to the Stockade immediately. This was done, and an interpreter questioned the prisoner. He turned out to be one Toshio Tagawa, age 19. He was a first class seaman, who had been on shore-duty on the Island for about 2 months before D-day. He answered questions willingly, and seemed to have no conception of security. He was clearly not well, weak, sickly, undersized, and had a bullet wound in his back.

1. Receipt from POW camp, Saipan, Marianas Islands.

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Colonel Campbell was faced with a rather hard decision at this point. The men had captured a Jap, who later on, might have taken American lives. But at the same time, they had violated explicit orders not to visit the part of the Island which they did. He decided that they should be punished, and their Squadron was notified accordingly. Thus the three prospective heros, suddenly found that they were just a little less than that.

The second prisoner provided an even more interesting story. He, strictly speaking, was not taken captive. He voluntarily surrendered. At about 2030 of the night of Oct. 5, Sgt. Clyde Nichols of the 871st Squadron was sitting in the Squadron Armament tent writing a letter home. This tent happened to be the last tent in one corner of their bivouac area. He heard a noise behind him, and something that sounded like double-talk. He was interested in composing the letter, so paid no particular attention to the interruption. After a few moments, the muttering was repeated, and the sergeant turned to see what the trouble was. To his great consternation, there stood a Jap. Nichols first problem was to get a gun. The Jap was between him and where all the gunswer stored. So Nichols started a circling movement, which brought him closer to his gun. He grabbed it, covered the intruder, and yelled for help. While waiting for nearby friends to appear, he suddenly realized that at no time had the Jap showed any aggression. As a matter of fact he acted very meek, and seemed somewhat astounded at the commotion. Also he had kep his hands folded on the top of his head, if not actually straight up in the approved surrender fashion.

This prisoner was brought to Group Headquarters, questioned briefly by Cpl. Wong, an enlisted Chinese boy, who spoke Japanese. But it appeared that Wong and the prisoner did not speak similar dialects, because after a short talk, followed by an exchange of notes, the status of the prisoner was still uncertain. All that was clear was that he had been wounded by a bomb burst, that he was hungry, that he was surrendering and that he wanted to stay and work with a shovel. He was very insistent on this latter point, when the timecame to bring him to the stockade. He refused at first to join Lts. Power and Black when they tried to induce him to quit the tent and get into a nearby jeep. No, no, his gestures showed, I want to stay here and dig.

This particular idiosyncrasy was explained at the interrogation at the Stockade.[2] His name was Takaski Olomo. He was a member of a conscript civilian labor battalion, which, about 2000 strong, landed on the Island about 40 days before D-day. During the early days of the invasion, he reported that all but 4 of his organization were killed or wounded. The four took to the hills, but were soon found by a marine patrol and scattered. He had been living in caves in the hills high above the camp, and living on sugar cane and rain-water. But he had been gradually getting hungrier. He had watched the American soldiers dig and work all day, so, figuring that such was the reason he had been brought to Saipan, he decided to come down and help the American work, and maybe get some food in eschange. At least, such was his story.

There were some interesting sidelights to this chapter. Both prisoners had been wounded, and were sickly-looking, and very thin. Both talked freely. Both seemed highly appreciative of proffered medical aid, and the courtesies extended them.

2. Receipt from POW Camp, Saipan, Mariana Islands.

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The attitude of the average G.I. was interesting too. Seeing his first Jap prisoner, he reacted just about as might have been expected. At first, he was inclined to hoot and stare. But this quickly gave way to sympathy for the puny, beaten Son-of-Heaven before him, and he gave him cigarettes, candy and food in profusion. It should also be stated that all such favors, were gratefully and politely accepted - even with a ceremonial bow by the civilian.

Out of all this, there was one item which completely baffled your Historian. The most prized gift, to the laborer, in fact one which was requested by gestures, was a number of dry crackers from a box of K rations. There indded is a big gap between the Jap and American way of thinking.

6. The First Practice Mission

After the minor disappointment on October 12, when the first B-29 to arrive at Saipan, turned out to be a plane of the 498th, and not the 497th, all personnel kept an eye skyward, watching for the first plane belonging to the 497th. They had to wait until the 19th. On that date, the first plane came in, piloted by Lt. Wagner of the 870th Squadron. A few minutes later Capt. Hahn, of the same Squadron landed.

From that day on, two or three planes arrived each day. Colonel Wright and Major Morgan arrived on the 20th. Lt. Col. Haynes landed on the 23rd, and Lt. Col. Davis came in on the 28th.

During this time, the members of the Air echelon began to arrive. The first contingent arrived by A.T.C. on 21 October. Among the arrivals were Major Dossett, Major Broadhurst, Major Gilmore, Captain Meigen and several other officers and enlisted men. The remaining members of Group Headquarters came in shortly thereafter, to be followed in turn by the Air echelons of the three squadrons.

The Ground Echelon was quite proud, that on the day Colonel Wright arrived, and he was the first to come in after the planes of Captain Hahn and Lt. Wagner, that the whole area was ready. There were a few odds and extras not quite finished, but the Mess-hall, quonsets and tents were all up. The latrines were all blasted. It had been hard work, but it was done, and a healthy feeling of satisfaction felt by all concerned.

The 28th turned out to be a big day for the Group. It was on that day that the first practice combat mission was flown. It was deemed undesireable, to make the first mission, the Tokio run, and high Headquarters had decided that a mission should be planned against some Jap island or territory, where some combat experience could be gained under not too rugged conditions.

In due course, the Group was notified that Truk Atoll was to be the target, with the submarine pens on Dublon Island, as the aiming point. Nine B-29's from the 869th Squadron formed the first element to go over the target, with nine (9) planes from the various Squadrons of the 498th Group, making up the second element.

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Each of the 869th planes carried twelve (12), 500 pound G.P. bombs. The fuel load was 5440 gallons. The distance flown was 1480 nautical miles. Take-off for the first plane was at 2030Z, 27 October, 1944. The first plane returned at 0242Z of the next day and the last at 0311Z. Two planes were air-borne, but did not reach the target. One of these returned because of a blown-out cylinder, and the other because of a runaway propeller. The target was attacked from an altitude of 25,000 feet; with General O'Donnell and Major Morgan in the lead ship.

The opposition was very light. Anti-aircraft fire from the oft-bombed Island, while of heavy caliber (probably 75 mm), was quite inaccurate, with bursts from 1500 to 5000 feet low, and there were only a few scant bursts. The air opposition was practically nil. Only one fighter, probably a Zeke, came up to meet the formation. He stayed well away from the formation, though twice he came in to about 900 yards - possibly to try to identify the type of attacking aircraft. His main function probably was to transmit the height of the formation for the benefit of the ground gunners.

For a first combat mission, the bombing was excellent. The photographs showed 40 bomb bursts within the target area. It really was a great thrill to those participating, because for those who had no combat experience, they could not say that they had been under fire.[3] Also, they had seen a real Jap plane at rather close range. However all realized that it had just been a practice run, and that in the very near future, when the rest of the Group had arrived, the big and important job of tackling Tokio would be scheduled. Most personnel were quietly satisfied, but reserved any celebrating until the Tokio mission was safely under their belts.

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3. Group Consolidated Mission Report Narrative, for Mission No. 1.



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*468TH BOMBARDMENT GROUP

Office of the Intelligence Officer

REPORT OF CRASH OF A/C #6271

Airplane was on a flight transporting cargo, consisting of gasoline drums etc., from the base at S-1, India, to forward base at A-7 in China across the Hump on 7 June 44.

After approximately five hours flying and while over the mountains one-hundred miles south of destination at approximately 19,000' #2 engine suddenly began smoking from the upper cowl flaps. At this time, the power setting was 35 inches Hg and 2200 rpm. Approximately one minute later the smoking stopped and a severe oil leak developed, apparently in the nose section or thrust bearing. At the same time, #2 propeller over-revved to 2800 rpm. The engine was throttled immediately and the propeller governing switch was turned to the decrease rpm position but the over-reving continued to 3200 rpm. The air speed at this time was approximately 188 miles per hour. The propeller feathering switch was pushed immediately, without effect. No drop in nose oil pressure was observed when the propeller feathering switch was pushed. Several attempts were made to feather #2 engine without success. During this period the airplane was losing altitude steadily. The pilot then attempted to control the runaway engine by decreasing the air speed and lowering the wing flap to 25 degrees. After reducing air speed to 170 miles per hour, the propeller slowed down to approximately 1900 rpm. Full power of 2600 rpm, 47.5 inches MG was used on the other three engine in an attempt to maintain altitude at this slow speed.

At approximately 17,000', the pilot ordered all possible cargo to be salvoed. This was done with the exception of two gasoline drums which had been tied on the cat walk of the aft bombay. The gunners attempted to cut these drums loose and push them out the bombay without success. They became wedged against each other in such a manner that the rear bombay door could not be closed completely, remaining open approximately six inches. The forward bombay doors were closed.

The Navigator reported that the propeller dome and the nose section on #2 engine were becoming red hot. It appeared that the engine was ready to disintegrate. The plane was still over the mountains, just above the cloud layer and the exact location could not be definitely determined. The air speed was approximately 120 mile per hour, and the plane was descending at about 800' per minute. Not being sure of his exact position with relation to the mountains, the pilot ordered the crew to bail out. At this time practically all of the oil in #2 engine had been lost and the oil pressures on the nose and rear sections which had remained constant at their normal settings, began to drop and the oil temperature began to rise.

*XX Bomber Command Walk-Out Reports, B-29 Combat Crews, through September 1944 in History of the XX Bomber Command Fourth Phase, Historical Study Number Two, "The Transport Project" Supporting Documents.

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The loading list read as follows:

| | | | |
|---|---|---|---|
| Pilot | Major | J. L. Pattillo | 0-400937 |
| Co-Pilot | 2nd Lt. | G. O. Matthews | 0-807014 |
| Navigator | 1st Lt. | R. L. Cournoyer | 0-667142 |
| Bombardier | 2nd Lt. | R. V. Irby | 0-749016 |
| Engineer | F/O | R. M. Roberts | T-192787 |
| Senior Gun | Sgt | H. G. Brogdon | 34644478 |
| Radio | S/Sgt | T. M. Keegan | 12132951 |
| Left Gun | Sgt | S. M. Klusovsky | 15330756 |
| Radar | 2nd Lt. | R. M. Humphrey | 0-864210 |
| Right Gun | Sgt | W. H. Troy | 39021672 |
| Tail Gun | Sgt | C. M. Frey | 39109496 |

After sending a distress signal and ascertaining their approximate position by D. R. the pilot ordered the crew to bail out. All eleven chutes were seen in the air floating to the ground. The plane crashed to the earth some distance away and was seen to explode. Photographs submitted with this report substantiate the statements of several crew members that the plane exploded on hitting the ground and was completely destroyed.

S/Sgt Keegan experienced some trouble with the prop wash of the plane as it spiraled past him to the ground. It nearly dumped the air out of his chute as it tipped him at an angle of nearly 60° but he managed to keep it straight. His story as given by him on interrogation from that point on reads as follows:

"Being down to 200', I saw rocks and a swift current below. I slipped my chute and hit on the rocks and bounced out into the river into water over my head. My chute was caught in the current and started to drag me downstream. The chute then snagged on some rocks and I then managed to wedge my body between two large rocks. I managed to unsnap the top snap of the chute and at the same time I lost my hold on the rocks and was dragged feet first, with my body below water, downstream. I then unstrapped one of my leg straps and slipped out of my chute. I then swam about ten yards to the shore. I lost my chute, jungle kit, and escape kit in the river. I rested for about ten minutes, then proceeded to a nearby farm house. I showed the natives my flag and gave them some of the money from my money belt, both paper and coin. They then took me to a school house where I was told to take off my wet clothing and was given dry clothes. Then they gave me something to eat. I then explained that I wanted to go to the other side of the river I could see Sgt. Klusovsky and Lt. Irby who were being carried by two Chinese. When the boat was ready to leave I heard someone call [illegible] and saw F/O Roberts on the side of a large hill in front of me, waving his pilot chute. I then got out of the boat and went after him. Both of us came back to the boat. He then told me that Major Pattillo had landed about one mile from him. We then got into the boat and went across the river where we met Sgt. Klusovsky and then the three of us started walking upstream. We walked about four miles, came to a house where a Chinese electrical engineer lived who could speak English. Here we met Lt. Irby, Sgt Brogdon and Sgt Frey. There were then six in our party."

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Lt. Journoyer was also tossed around quite a bit by prop wash on the way down. His story from just before landing reads as follows:

"I looked down and saw landing was going to be in a river. Because it was rapid I pulled back the shroudlines and finally lighted on a sand beach a few feet from the river. I attempted to talk to natives in a boat by use of Ding-How, Blood Chit and sign language to get them to take me to the other side of the river. The natives finally understood but the ferry rope line broke down. I ate rice lunch with Chinese fishermen who did not accept CN or silver. I started up mountain to plane with aid of guide but after three minutes I heard shouts and discovered Lt. Humphreys on top of a 1000' cliff and he said to stay where I was, that he would be down. I put my chute in a boat. A native motioned to a village north on the river, where I met Lt. Humphreys. I tried the flag and it worked - a very enthusiastic reaction. I decided to wait till morning when all of a sudden Major Pattillo walked into the village accompanied by natives. We located several Chinese in European dress who spoke a little English but got along better writing. One Wu Po Jung invited all of us to stay with him at night. We walked for four hours from 6 to 10 over a path running along the edge of the river - got suspicious but checked with jungle kit compass and fly button compass and determined we were going north. We arrived, after a short boat ride, at a little town where he was the magistrate. We were told to expect more of our friends at his house tomorrow. We slept in a school house next day. We ate dinner and made fast friends by burping with pleasure. We were accompanied by soldiers at every move. We were told the following day that our friends would not appear till the next day - got a little suspicious but later that night the other six did appear. After "bulling" found that Major Pattillo was last out of the nose and Sgt Alusovely was last at rear therefore we knew that the men who were last had got out of the plane. The next morning we left by boat for Lo Shan."

On the evening of 9 June 1944, the nine survivors arrived by boat at Lo Shan and were escorted to the headquarters of General Han, commander of the Chinese garrison. They were then installed in several rooms on the top floor of a three story Chinese hotel located in the heart of the city not far from the garrison. The rooms were equipped with crude beds, chairs, wash stands and mirrors and appeared reasonably clean. The bed clothes were however not so clean and were found to have already been used.

Word of the arrival of nine men at Lo Shan was received at A-7 on the morning of 10 June and at 1300 a rescue party consisting of Lt. Trafton, Med. O. at A-7, Lt. Phelan, Intell O. at A-7, three enlisted men and a Chinese interpreter started out for Lo-Shan with a jeep, and an ambulance. A weapons carrier also went along carrying supplies of gasoline, oil, feed and blankets.

After a trip over typical Chinese dirt roads, the convoy arrived at Lo-Shan about 1630 and went to the headquarters of General Han after being checked in at PoliceHeadquarters on reaching the outskirts of the city. The types and numbers of each vehicle were recorded on the local register. From the headquarters the Party was lead to the hotel where Major Pattillo and eight others had been quartered over night.

Medical examination by Lt. Trafton revealed that Sgt. Brogdon had suffered a severe back sprain, that Lt. Irby had a mild sprain of his right



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foot, and that S/Sgt. Keegan had multiple bruises and sprains. Several of the crew were suffering from mild cases of dysentery resulting from the Chinese diet of the last two days, but none were seriously ill.

Immediately after the medical examination, Lt. Phelan, conducted a preliminary interrogation designed to gain information as to the possible whereabouts of the two men who were still missing: Lt. Matthews, the co-pilot and Sgt Tidy, a gunner. As Major Pattillo and Sgt Klusovsky were the last out of the plane from the front and rear, respectively, it was conclusively shown that the missing men had left the plane. Reports of several crew members coincide on the point that all chutes had opened, as several men counted ten chutes in the air in addition to their own. One man falling nearest to the crashed plane is certain that none fell into the burning plane.

By the time all the data was gathered it was getting dark and it was concluded that it would be fruitless to send out a search party until daybreak on the following day. At about that time a Chinese Officer arrived bearing written invitations to the entire group, crew and rescue party alike, to attend a banquet as guests of General Han. The invitations were addressed by name to all crew members, and in blank to recently arrived members of the rescue party.

Before accepting the invitations, arrangements were made through officers representing General Han, and persons representing the magistrate of Lo-Shan, that guards should be placed at the scene of the crash at once, and that natives in the area should be advised to be on the watch for the missing men. Plans for a rescue party to leave at daybreak were completed and it was agreed that Major Pattillo with one of the other crew members, M/Sgt. Silva and the Chinese interpreter, and representatives of the magistrate and General Han would make up the party. All but those crew members who were injured attended the banquet tendered by General Han at his headquarters which were located at the very top of a high hill overlooking the city. The garrison appeared to be well organized and the soldiers were alert and reasonably well equipped with the usual Chinese small arms.

The party was shown to General Han's inner office which was a room about 20 feet square finished with divans and chairs around three sides of the room, and two fine desks, highly lacquered and shining, set back to back before half open paper windows. The walls were decorated with Chinese maps and charts. The receiving line included General Han, two lesser generals, a Chinese woman about 40 years old who had graduated from Cornell University at Ithica, New York about 1920 and whose husband is now lecturing in the United States, and a Chinese school master also educated in the U. S.

Tea was served while the usual talk and discussion of the crash went on through the Chinese woman who acted as interpreter and hostess. General Han was interested and politely but not overly curious about B-29's and the part they were to play against Japan. After about twenty minutes, supper was announced, and the party adjourned to the dining hall, a large room about 60 x 30 feet through which the party had passed on the way to the office.

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The table was set in European style with good table wear, china and glass wear. The meal consisted of many courses, mixed with the usual Chinese manner soup being a middle course, and a meat course coming last with desert in between. The courses included fish, chicken, duck, soup, glazed bread, ham and eggs and one or two courses the nature of which it was difficult to ascertain. The meal was featured by the serving of fine rice wine of a golden hue. Two boys did nothing but keep the tall stemmed glasses filled with the wine as soon as they were drained. General Han and one of his aides gave picturesque speeches of welcome, stressing Chinese-American friendship both during and after the war. The existence of England as a present ally or future friend was completely ignored, and England was not mentioned at any time during the entire evening. Major Pattillo responded on behalf of the guests, and made an excellent impression. Toasts were given honoring the Americans, the Chinese, each crew member, his wife, sweetheart, and children, any excuse for another drink. The dinner ended abruptly around nine o'clock as it appeared that the general had pressing business to attend to, probably his new bride who had not been present at the banquet.

After returning to the hotel other Chinese Officers arrived to confirm arrangements for the morning search. A restless night was experienced by all, largely because of the unauthorized and unwelcome visitors in our beds. On the morning of June 11, Lts. Trefton and Phelan with seven crew members made the return trip by jeep and ambulance to A-7. (An offer by the rescue party to pay the hotel bill was declined, the answer being that it was taken care of by the magistrate who knew that we did not have enough money with us to pay the bill.)

Major Pattillo and his search party made the trip back to the scene of the crash and verified the fact that the plane and all confidential equipment had been destroyed in the crash. Photos attached to this report were taken at the scene by Major Pattillo. They arrived back at Lo-Shan on the evening of 12 June without having found any trace of the missing men.

On their arrival at Lo-Shan, they were told that a body had been found in the river about half way between Lo-Shan and the scene of the crash. Later investigation revealed that it was the body of Sgt. Tidy, one of the missing crew members. The body, badly bloated from the many hours in the water, showed head lacerations, death probably having been caused by drowning. A Chinese casket had been provided by the Chinese and the party returned to A-7 with the body.

The following observations and suggestions were made by the crew members:

1. It was thought that the Chinese silk maps were not very accurate and were confusing.

2. The Pointie-Talkies met with varying success, not being understood by some of the Chinese.

3. The blood chits also met with varying success. They were not so successful with the local natives, but were very successful with the Chinese soldiers encountered in the area.

4. It was suggested that Mae Wests be worn over this country as the mountain rivers are swift and deep. (This suggestion has since been complied



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with, the wearing of Mae West's on the hump trips now being SOP in the 443th Comb Gp.)

5. While the money was successful and probably helpful it would not have been absolutely essential to rescue in this particular area. Money was refused on some occasions.

/s/John V. Phelan
JOHN V. PHELAN,
Captain, Air Corps,
Interrogating Officer.

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*Headquarters 468th Bombardment Group
Office of the Intelligence Officer
APO 493

11 July 1944

SUBJECT: Report of Crew of A/C 42-6314 -- Lt. Sloan, Pilot.

TO : Commanding Officer, 468th Bombardment Group, APO 493

1. On 8 June 1944, B-29 42-6314 took off from A-7 at 0838, local time, returning to B-1. On 3 July 1944, Wing at A-1 received word from Chinese sources that ten members of the crew were walking out from an area to the southwest of I-Pin. These ten reached I-Pin on 6 July 1944. The next day they were picked up by a C-46 and taken to the AAF hospital at Cheng-Tu. The loading list of A/C #314 on 8 June 1944 was as follows:

Crew of A/C #314, 793rd Bombardment Squadron, 468th Bombardment Group.

| | | | |
|---|---|---|---|
| 1st Lt. | Leslie J. Sloan | 0-794710 | |
| 2nd Lt. | Frank W. Holmes Jr. | 0-443988 | |
| 2nd Lt. | Vincent R. Casazza | 0-811554 | |
| 2nd Lt. | Charles B. Grey | 0-864811 | |
| 2nd Lt. | Robert E. Casey | 0-865159 | |
| S/Sgt | William C. Sene | 16048658 | |
| Cpl | Virgil W. Bailey | 6273178 | |
| Cpl | William L. Shufelt | 35624680 | |
| Cpl | Hohn H. Moore | 6981418 | |
| Sgt | Frances P. Reed | 12165680 | (Killed) |
| 2nd Lt. | Carl B. Ray | 0-752082 | |

2. On 10 July the members of the crew were visited and interrogated at Cheng-Tu by Major George P. Putnam and Lieutenant John V. Phelan, 468th Bombardment Group Intelligence, accompanied by Captain Paul Frey, Wing A-2, and Captain H. M. Berry. In the following report the information secured in those interviews is set forth:

Lieutenant Sloan, Pilot, gave an over-all picture of the accident itself, and its aftermaths, which was substantially concurred in by all members of the crew, all of whom were interviewed.

At "about nine o'clock India time" Senior Gunner Shufelt reported over the interphone that there was a fire in #3 engine. Almost immediately an explosion occured in the engine, which shook the whole ship "with a definite jolt". The Engineer released the extinguisher and apparently the actual fire was put out. The plane had just leveled off at about 22,000 feet, flying above an undercast, with power setting 2300 and 38 inches. It was Sloan's opinion, shared by the engineer and Senior Gunner that it was a piston which went through the cowling, tearing a jagged hole about a foot across, in the

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top center of the cowling. Sloan pulled back power and hit the feathering switch. The engine started to feather and went down to about 900 rpm. Then it went back to about 1400 rpm. Sloan turned the ship over to Co-Pilot, ordering 180 degree turn, which was made while Sloan and the engineer tried to get control of the engine, which would not feather. The engineer shut off mixture control and shut off gas line. Meanwhile the other three engines were functioning normally. Air speed fluctuated between 150 and 200 mph. "Manifold Pressure" said Sloan, "went up, though I can't explain it, as with the switch cut off no gas was going to the engine.

About four minutes after the explosion #3 prop started to run away. It got between 2800 and 3000 rpm and the plane commenced to shake terrifically. The facts as described in the two quotations from Sloan were substantiated by the Co-Pilot and Engineer.

The aircraft was losing altitude, apparently several hundred feet a minute. Sloan directed all hands to prepare to abandon ship, and released cabin air pressure with the release situated beside the pilot seat. Sloan then lowered the wheels and told all hands to bail out. The men in front went down through the front-wheel well. Those in the rear went out through the door beside the put-put, except the tail gunner who used his emergency exit. All went out feet first, those in front in the following order: Bombardier, Navigator, Engineer, Radio, Co-Pilot, Pilot. Sloan believes the ship was at about 20,000 feet when he left it. He believes fire had resumed in the engine, though others do not all agree. Certainly oil-smoke appears to have been pouring through the hole in the top of the cowling.

Sloan believed everyone had left the ship when he jumped. Actually, one man, Sgt Frances Reed, left gunner, never left the plane. His companions in the aft section saw him with his chute on, and supposed he would jump following the right gunner. But Reed's body was identified subsequently by two crew members at the wrecked plane.

Sloan says that after bailing out, the last he saw of the aircraft "she was flying straight and level". He had not set automatic pilot. Descending below the undercast Sloan saw "seven or eight" of the others on their way down. He landed northeast of them, possibly several miles. During the drop, and in the plane immediately preceeding, after it had been depressurized, no one reported ill effects from lack of oxygen, and no one blacked out from lack of oxygen whenchute opened or sustained major injury on landing.

Sloan's own landing, however, was not easy. He said: "On the way down you have a sensation you're going to float forever. Then when you begin to near the ground, you realize you're going in a hell of a hurry. I struck a good sized tree, crashed down through branches and finally hung about 15 to 20 feet above the ground, my chute caught in upper branches. I pulled in to the trunk, using branches to help me, unbuckled the chute, and unfastening the jungle kit, I let it drop, scrambled down the tree trunk and then slid down a steep slope to where the kit had landed."

Shortly, Sloan heard Chinese voices. He fired his forty-five, but had no response. Descending further, at the base of a cliff, he saw a Chinese who waved to him to come down. Thereafter he fell in with three Chinese,

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one about 35, one perhaps 18 and a boy. None spoke English. Sloan's pointie-talkie contained only Burmese and was useless. Hearing other voices, the Chinese directed him to be still.

The Chinese took him to a house at the end of a trail, which they reached after scrambling through thick growth, so wet he was soaked. It was a mountainous country, with steep slopes and cliffs and jungled undergrowth, with maximum altitudes, Sloan thought, of about six or seven thousand feet.

After sleeping a couple of hours at the house (Sloan was exhausted) he insisted on going in the direction of the plane. Already there were odds and ends of wreckage scattered along the trail indicating natives had been carrying off what they fancied.

Sloan and his friendly companions were joined by others, smaller men, not so flat-featured as the Chinese, apparently more Mongolian in appearance, and doubtless members of the Lolo tribe.

"They were pretty rough lads", said Sloan. "They tried to take away my forty-five, but I managed to keep it". He was assisted by the young Chinese, whose name phonetically spelled, was Sadingtou.

Sloan was then taken to the Chief's house. Sadingtou, and the rest of them, smoked opium and invited Sloan to join which he refused. Sloan was then taken to another settlement, fed rice and pork, and some of his remaining rations were taken away from him.

The next day Sloan was discouraged from moving off, and all hands rolled opium pellets and hit the pipe. "Time meant nothing" said Sloan. "I tried to find out about the rest of the crew, and tried to get started to the wreck but could do nothing."

In the evening of the second day they finally moved on to another village. On the third day, Sadingtou (who was pretty consistently befuddled with opium) indicated with pantomine that nine men of the crew were safe, one dead.

That evening Sloan finally contrived to get the others to take him to where seven of the crew members were, two of them, at the time, having gone to the wreck of the plane. Returning, these two, Moore and Shufelt, told Sloan they had found the body of Reed in the wreck, positively identifying it, although everything like watch, tags, belt etc had been removed. (This was two days after the crash, and the first time any crew members had been able to reach the plane. The following day, the local Lolo chief stated that the body had been buried, near the plane.

The next eight days were spent in "hanging around". Sloan and the crew apparently were unable to get any action and were discouraged, almost forcibly, from getting under way. They did not apparently, make any direct offers of reward which would be paid if they were safely delivered to friendly Chinese. In the meanwhile, (as indicated in subsequent interviews) several of the men were robbed of everything they had except their clothes. All but



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two money belts were stolen. And the bad condition of Holmes leg, badly bruised, further contributed to the difficulty of getting started. Incidentally, the blood chit made no impression on these people. They seemed to like the Chinese as little as the Chinese like them.

On the 11th day they were told they could start. The Chief gave them one of the jungle kit frying pans, full of opium paste, to help them pay their way as they went along, and one of the stolen mosquito nets, full of popcorn.

That night they stayed at a house across a mountain ridge, where a pig was killed to feed them. Despite the wildness of the people, all tillable acreage of the region seemed to be farmed.

The night of the 12th day they stayed at another house. That day, CAVU, planes passed over head and they signalled with mirrors. They walked each day they were moving from ten to twenty miles. In all, they think they covered about 200 miles. GI footwear with rubber soles proved first rate in every way. Extra socks were recommended for inclusion in the jungle kit.

The 13th day following the crash they reached a Chief's house, near the river. There, in the valley, they encountered the first mosquitoes. Their best protection was what they could devise from a parachute and a half, all that they had been able to keep from the Lolos. The big treat at this valley chief's house was round flat pieces of hard brown sugar, which tasted very good indeed after the pork and goats meat and potatoes they had been eating almost exclusively, for most of their rations had gone to the Lolos.

There they stayed four nights. Then in a boat they "crossed a rough, fast river", and a lad whose name sounded like Shunway, joined them. The new friend warned them "the people in the town (where they were headed) are not to be trusted". At that town three Chinese soldiers, one of whom spoke a little English, tried to persuade them to go with them southward. But Sloan and the others distrusted their intentions, and they stuck with their Chinese companions and continued to head for Leipo.

The day before they finally reached Leipo, as they were following the river, shots were fired at them from the opposite bank. The Chinese boy indicated they should wait until darkness came-- all hands were down behind protecting rocks-- but after a few hours, firing having discontinued, they moved on.

That night was spent on the river bank opposite Leipo. In the morning they crossed by boat, and reached Leipo, where the Chinese Magistrate treated them handsomely, caring for them at his house, providing good food, boiled water and even having their clothes washed.

From Leipo three stretchers and an armed guard accompanied them all the way to I-Pin. On the second day out from Leipo part of the Chinese guard went ahead. They, and some merchants moving with them remained with the balance of the troops. Shortly there was firing ahead. Then a bugle call, and they moved on. The bodies of several freshly-killed Lolos were encountered, and the head of one was displayed on a stake, to the obvious satisfaction of the soldiery and the merchants, whom the Lolos apparently had a habit of robbing along this special stretch of road.



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Co-Pilot Ray said he saw "a jagged hole about 12 inches across in top of cowling. Smoke was pouring out at time he jumped, and he believed fire had started again. When the chute opened, either my 45 or the buckle hit me in the head and I was nearly knocked out. Looking around he saw Bailey going down very fast. It looked as if half his chute was gone." Actually three panels had ripped out) On the ground the natives took everything we had.

Engineer Casey said he believed "something in #3 engine blew up or gave way. Perhaps a head gave way and a piston went out. He did not think the engine was on fire when they jumped.

Tail Gunner Moore was one of the two men who saw the wreck of the plane. It struck on a steep slope, apparently headed down the slope, almost in a diving position. Everything about the aircraft was demolished, scattered in small fragments. Apparently there had been an explosion and considerable, though not a consuming fire. He saw no papers or identifiable parts of secret equipment. He saw and positively identified the head of Sgt Reed, though no tags or other personal items had been left by those who evidently had taken away everything they took a fancy to, in the two days intervening between the crash and the visit of Moore and Shufelt. Reeds body was unburned. Both legs were severed above the ankles. One foot was found 100 yards distant, the other foot, and a severed right arm lay near the body.

Senior Gunner Shufelt substantiated Cpl Moore's statements. He too said he definitely identified Reed. At time of explosion while in flight he said he saw something go out of the top part of cowling apparently over rear row of cylinders. After the effort to feather had been unsuccessful, he said "the vibration in the back of the plane was very severe". Before jumping (he was first out of the men in the rear) he saw Reed with his chute on and could offer no reason why he failed to jump.

Right Gunner Bailey was last to leave the rear exit. One foot caught and he was flattened against the fuselage by the slip stream, and succeeded in getting free only with the greatest effort. When he did get clear and pulled the rip cord, three panels of his chute were ripped out. It was a smooth tear and was not jagged. He does not believe that it tore when he jumped. The chute had been repacked a few days before this mission. He believes no injury to the chute was sustained while he was hung up in the door. Despite the speed of his descent, he suffered no material injury when he struck the ground. Like Shufelt, he saw Reed apparently ready to jump. Normally, Reed would have followed him to the exit. Had Reed reached this exit, he would have helped Bailey get free, but Bailey got no such help. The ship at that time was not moving violently, this in the opinion of Bailey and Shufelt, minimized likelihood that Reed was thrown about and possibly rendered unconscious by striking his head.

Bombardier Cossozza and Radar Officer Gray supplied no information at varyance with the general story as outlined above.

Lt. Holmes, Navigator, reported that the explosion occurred at 02292 (0929 China time). He placed the time in relation to his ETA at Hsi Chang which was their first turning point and which they had just reached when the fire broke out. He said that the ship continued on course instead of



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making the turn and then turned into a heading of 10° back toward A-7. He did not have his chute adjusted properly and he was knocked out by the jolt when his chute opened. He came to just before he hit the ground, but landed hard on a rock and was knocked out again. When he came to again, he found that everything was gone including his ring, wallet, money-belt, and 45 automatic. He still had his chute but this was taken away shortly afterwards by one of a party of seven Lolos all armed with rifles.

S/Sgt Sene, Radio Operator, gave a routine position report to Kunming by voice on 5530 KC and obtained the usual clearance to proceed just before reaching Hsi Chang. He then changed to another frequency to call A-7. Before he could get tuned in, the emergency arose and he swung back to 5530 KC and gave their position (approximate) and heading (10°). As the others were bailing out he did not await a reply. He does not know whether the message was even received and did not say that they were bailing out. (Note: It is possible that he did not get tuned in again to 5530 KC as we have never been advised that any such message has been received at Kunming or elsewhere)

Attached to the report is a sketch showing the location of the accident and the route taken by the crew to I-Pin.

/s/ George P. Putnam,
GEORGE P. PUTNAM,
Major, Air Corps,
Intelligence Officer.

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* FORWARD ECHELON
HEADQUARTERS
444th BOMB GROUP

12 July 1944

SUBJECT: Report on A/C 42-6246.

TO : Commanding Officer, 444th Bomb Group,
APO 215. Attention: S-2

1. This is a report on B-29 aircraft number 42-6246, piloted by Capt. Wayne T. Mann of the 679th Squadron, which went down in China on 28 June 1944. All the crew were saved, and this report is based on the informal statements of Lt. Ira S. Paul, Co-Pilot, and Paul F. Sullivan, Engineer, to Robert N. Chambliss, 1st Lt, AC. Interrogation took place on 12 July 1944. At the time three members of the crew, including Capt. Mann, were in the hospital, while two had returned by ATC to India, including the Navigator. This A/C being a tanker, it only carried a seven man crew.

2. A/C #42-6246 left Kharagpur, India, at approximately 0020Z, 28 June 1944, with a gross weight of around 129,000 pounds. Climb was made on course to 19,000', and the hump was crossed without incident. Engines were all running hot however, and at one time #3 kicked to auto lean and had to be put back on auto rich. As the plane approached Sikang it was necessary to pull 39 inches manifold pressure and 2300 rpm to maintain altitude and flying speed. About 0415Z manifold pressure and rpm dropped on #3 engine and oil pressure went out. The prop was feathered at once. There was an undercast all the way and some turbulence. With #3 feathered #1 fell off at once and the ship started losing altitude in very high country. It also went into a 30° bank. The co-pilot ordered bailout over the interphone, and two minutes later bailed out at about 0417Z. The co-pilot opened the hatch and went out, followed by the Engineer, Radio Operator and Navigator in order. A ground maintenance man and the tail gunner stayed for some reason until the pilot had straightened the ship, put it in a slight circle and jumped. Then the ship mushed and the two men in the tail jumped. Bailouts were from 18,000' to about 12,000'. Position was about 27° 33' N, and 101° 32' E.

3. About 0426Z the aircraft hit a mountain and blew up. Landings were made by crew members on the slopes at about 8500'. The Co-Pilot and Engineer landed close together on a slope. Across the valley they could see a parachute, indicating other crew members. Immediately on landing these two men were approached by Laoying Indians of a color resembling iodine, without slant eyes, and each wearing a long blue robe fastened at the neck. These Indians could neither read nor write. They were not impressed by the American Flag, the uplifted thumb, or paper money. They were impressed by the presence of a pipe, by hard money, and by salt which seemed to be a precious commodity. A large percentage of these Indians

* XX Bomber Command Walk-Out Reports, B-29 Combat Crews, through September 1944 in History of the XX Bomber Command Fourth Phase, Historical Study Number Two, "The Transport Project" Supporting Documents.

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have goiters in one form or another. By sending a note the radio operator and navigator were brought across the valley and the four men now together were taken to a village, where they spent two and one half days. They were treated well and were the object of extreme curiosity. They slept on mats near a fire in the back of a native hut, and got little sleep because of people coming in. The natives ate out of a community pot. These men resorted to jungle kits and were impressed with the need for more food, and also mosquito repellant in the kit. Only one of them had his money belt. None had the escape kit or any other food. Mosquitoes were thick. Rubberized silk maps were not so much help as some maps which the navigator had in his pocket. By these they determined their position and made known their desire to move. One man, a corporal, lost all his savings in the plane, and men should be instructed not to carry too much money on hump trips. No money was given to natives - just salt tablets, benzedrine, and other items out of the jungle kits. On the morning of the third day these four men started out down stream along a trail seeking a river. Late that afternoon they reached a Chinese Outpost and were welcomed into a compound and fed very well, then taken to Yenyuan, where there was a radio station. The pilot and two enlisted men were there bringing together the entire crew.

4. The crew spent one night at Yenyuan. The pilot had a swollen ankle, later found to be chipped, and after the one night the party set out for Sikang, with Chinese guards and guides and horses. They traveled fast, walking and riding (it was hard to decide which method was more strenuous) and reached Sikang in nine days, sleeping sometimes in villages sometimes in shacks, one night in Hosi with a French Missionary where they were royally fed. They were treated well at all times by the Chinese, and the trip, while strenuous, was not too trying. From Sikang these men were flown to Kunming. There they spent a couple of days and the navigator and radio operator returned to India by ATC. The rest of the men then were told to wait for a C-46, which brought them to A-1. They contacted no one there who seemed to know where they were to go, so caught a ride on a truck to A-3, where they were medically checked and interrogated, and are awaiting transportation to India.

5. These men were impressed by several facts. When parachuting weight is limited and must be distributed. The escape kit cannot well be placed in a position to conveniently carry down. If it can, this should be pointed out. A limited amount of money should be brought over the hump. More food should be in the jungle kit, which should be, if possible, released a hundred feet or more above the ground to lighten weight. In remote places hard money is better than paper money and trinkets are better than money. Salt tablets are good for barter and for the bailout, a pipe seems to be a friendly symbol, mosquito repellant should be carried along. Natives are curious, and if handled in a friendly manner are likely to be friendly in turn.

6. None of this crew were critically injured, though three are now in the hospital. Captain Mann has his foot in a cast, and two enlisted men are under observation for possible injuries to back and chest. All three are at Kunming. All were treated well by natives and brought promptly to civilization.

ROBERT N. CHAMBLISS,
1st Lt. Air Corps,
S-2 Officer.

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INTERROGATION OF 2ND LT. JACK POWERS BOMBARDIER OF PLANE #246

Plane 246 took off from Kharagpur at 0650 IST, 28 June, flew to Sylhet, Jorhat, though radio compass couldn't pick up homing, and on to Chaoua, radio compass picking it up just before it was reached. The Hump was covered by a solid undercast, but uneventful, though it was impossible to climb over 20,000' and pressurization wouldn't work.

As Lake Luku was sighted through a hole in the clouds, the pilot warned there might be trouble and for everybody to keep their parachutes on. At 1045, #3 engine went out and was feathered, then immediately #1 went out, but it was impossible to feather it. The landing gear was lowered, and upon getting the order to bail out, I plotted a position and stuffed two maps in my shirt. The co-pilot had opened the hatch and jumped, followed by the engineer and radio operator, so I climbed down into the nose wheel and let go feet first. I waited until the rushing noise slackened and felt descent was straight down, and then pulled the rip cord. The chute opened almost immediately with only a slight jolt. Two other chutes were observed in descent. On landing in a soft patch of grass and bushes at (27°37'N- 101° 35'E), with my chute partially caught in the lower branches of a tree, I removed the harness, lit a cigarette, and observed the plane still flying to the South in a large circle. A minute or so later, after losing sight of it, a large puff of smoke and flames was seen to the southwest, as it struck a mountain. My watch which I looked at instantly, showed 1056½.

At the time the order to fix parachutes had come, my jungle pack had not been attached because of the discomfort of sitting on it at the navigation table, and later, in the excitement of bailing out, time was not taken to fasten it on, as I took it for granted that this territory was populated with friendly Chinese, and I saw no need to add the extra weight and awkwardness of it or my pistol. The escape belt and kit were lost in the confusion of bailing out or landing.

Picking up my chute, I started down the mountain towards a stream, fell, and slid about 25 feet, and was picking myself up when two men came running toward me, each carrying a foot long knife. They looked unfriendly at first, but after I smiled, talked, and offered them cigarettes, they became much friendlier, one carrying my chute, the other letting me examine his knife. I made motions for food as a further sign of friendship, so we walked three quarters of a mile to a small village, extremely filthy with about 25 natives gathering around me. These people, who wore dirty tattered clothes, with long blue capes, were of a dark color, less oriental looking than Chinese, later proved to Lao-Lao tribesmen, the Chinese considering them very barbaric. They offered me a wooden bowl of the dirtiest uncooked corn meal possible, mixed with cold water. In order not to hurt their feelings, I ate every grain with chop sticks, though each one nearly nauseated me. I started down the mountain with my two original natives when a man with a horse offered me a ride. Some of the people made signs that another man with a parachute was down the stream, so going that way, I found the radio operator with about 50 men and women around him. The people here were very curious, taking everything from our pockets, passing them around, examining them and then returning them to our pockets. The Hair on our arms, of which they had none, fascinated them.

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After hearing three shots in the distance (these proved to be Lt. Paul trying to signal us), we waited around all afternoon until a note from Lt. Paul was brought telling us to join him, and that he had a guide to take us to an American Air Base. It had begun to rain however, so we spent the night in a hut on a pallet, after eating some hot soup and turnip greens. The next morning, the 29th, we were fed baked potatoes, which we considered the most sanitary food. While waiting for the rain to stop, the flight engineer walked in, whereupon we all set out over a mountain to reach the co-pilot.

We took turns riding a horse which one of the natives had. The second afternoon and night were spent in the very small village that Lt. Paul and F/O Sullivan had used the night before. I stayed in a little cleaner hut across the road from the other, the old man giving me his place by the fire. I gave them a small amount of Chinese money on leaving.

On the morning of the 30th, with the people trying to make us stay, we started towards a valley, walking most of the day. Two of the natives who had followed us from the village, let us pile the chutes and jungle packs on the horses. Late in the afternoon, we arrived at a small army outpost with a wall around it.

We were taken to the Chinese in charge of the post, who was extremely friendly and intelligent, giving us Chinese cigarettes, tea and noodles. An hour later, he served us an excellent Chinese meal. We learned that three more of the crew were safe. We spent the night here, and on the afternoon of the 1st, we left for Yen-Yuan, riding horses, reaching it in two hours with the intelligent Chinese as guide. Our names had been taken to Yen-Yuan ahead of us, and here we found Captain Mann, Sgt Lewis, and Cpl Roy. We stayed at a Catholic Chinese Mission that night. While at Yen-Yuan, the barrels of two 50 calibers and the 20 mm, charred with fire, were brought down from the mountain with the report that this was practically all that remained of the plane.

Sunday, the 2nd, we left on horses, with Chinese soldiers as guards, this having been arranged through the president of the district, who happened to pass through. We rode to a small place where horses were changed, and spent the night in a big stable with horses on one side, we on the other, and a guard between. The food was rough but clean.

After riding and walking all of Monday the 3rd, we spent the night in a small village remount station, sleeping again on pallets, with much noise from some of the natives, making sleep impossible.

The 4th of July was spent riding to Latung, and in crossing the Ya-Lung-Chiang River. This was done in a very crude boat which was pulled quite a way upstream by coolies, then the crew rowed like mad, with the stream sweeping the boat down-stream, but across to an eddy on the opposite bank. While we were waiting for the horses to be brought across in a much larger boat, we bathed and washed our underclothes in the stream, using the soap from the jungle kits. The night was spent in a little town travelling station.

The night of the 5th was spent in Ho-Hoi after riding and walking all day. A French missionary, the first white man we had seen, let us stay at his mission, and treated us royally.

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Hsichang was reached the afternoon of the 6th, after having ridden through a very fertile valley, with the people much cleaner and more industrious. A civilian who was sent out by the Chinese airbase at Hsichang to escort us in, reached us near Latung, but he had been of no help. We were taken to the air base where some American mechanics, who were working on a crash landed B-29, gave us a few supplies, the last that they had.

A radio message sent from here told of our safe arrival, the one sent from Yen Yuan evidentally not having been received.

We were flown to Kunming on the 7th, Captain Mann, S/Sgt Ozbolt, and Cpl Roy were hospitalized. I left Kunming on July 10th, stopping at Calcutta, Kalikunda, and arriving at Kharagpur on the 12th, taking a truck from there to Dudhkundi.

My failure to attach my jungle kit, pistol, excape belt and packet, canteen and pointie-talkie, could have proved very serious had I not been with others who shared theirs with me. They all proved extremely useful.

INTERROGATION OF T/SGT ARLIE F. LEWIS, TAIL GUNNER PLANE 246

I was sitting in the left side gunner's position, on oxygen at 20,000', watching the engines when the order to bail out came. Parachute, jungle kit, and escape belt were quickly fastened and the back door was opened. We, Cpl Roy and I, waited at the back door, watching for the ones in front to jump in order that we might land with them, but caught sight of no parachutes. After about two minutes, I went back to the inter-phone to call the pilot, but on getting no answer, and feeling the plane stall and dive slightly, we immediately jumped, Roy first and then I. We had no trouble getting out, the wind sweeping us clear of the plane. There was quite a jar when my chute opened, slightly straining my back. Immediately after the opening and while I was swinging violently, I saw the plane fly directly into the side of a mountain. It burst into a red flame.

There was another severe shock on landing. I crossed a small hill and finding Cpl Roy, we set off to locate Captain Mann when some Chinese soldiers came running up. I showed them the blood chit which they read, all the time laughing and jabbering, and examining all of our equipment.

We walked over to where some Chinese soldiers were helping Captain Mann down the mountain. They took us to the house where they were stationed and we spent the night there, the mosquitoes keeping me awake most of the night, although the parachutes were used for covering. On leaving, my parachute was given to these soldiers for their kindness. Captain Mann's ankle was badly swollen, so I bathed it in hot water and wrapped it with part of a chute, using the sulphur drug from the jungle kit for a cut on the Captain's chin, and for our scratches. Two halizone tablets were put in every rubber bottle of water that we drank.

The next morning we fed on jungle kit rations and hot tea, then leaving on horses furnished by the Chinese soldiers, we rode 16 miles to Yen-Yuan where a Chinese Catholic Mission was our stopping place for the night. The next day we heard that the other four men were safe and heading for this

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town, so we waited for them for three days. Though the missionaries treated us very well, feeding us eggs, ripe apricots, and other stuff, the bed bugs, mosquitoes and flies nearly ate us up. The people from miles around came to stare at us and examine our parachutes which fascinated them. After the third day, when the other crew members arrived, we left on horses and mules for Hsichang. As I had the GI's for some time, it was a hard trip. We slept in the same room with the horses the first night, with pigs and chickens roosting all around us.

The money from my escape belt was used to buy food and to tip the natives. The silver rupees were given to the women of Yen-Yuan to be used as a pendant. Chinese soldiers acted as our guides for five days on the trip to Hsichang, and they were wonderful to us.

After reaching Kunming by C-46, we had a physical examination, three being hospitalized. Three days later, the 10th of July, I left on a plane with Lt. Powers for Kharagpur, stopping at Calcutta and Kalaikunda, arriving at Dudhkundi on the 12th of July.

Suggested that more food be put in jungle kits, also some mosquito repellant and insecticide. A toothbrush would be really appreciated also.

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INTERROGATION OF 1ST LT IRA S. PAUL, CO-PILOT PLANE 246

I jumped straight through the well from the flight deck, falling about 1,500' through the undercast. After my chute had opened, I saw three others open. I landed in a small gully, overgrown with wild strawberries, having dropped my jungle kit from about 200' in order to lessen the weight. A native came down to me, leaving two women on the hill watching us, to whom I showed the blood chit from the escape belt. Although he couldn't read and didn't know what thumbs up meant, when I pulled out my pipe, he filled it with his native tobacco and was amazed at the matches I used. His lighter was an old flint and steel. He carried my jungle kit and led me towards other natives and thence to where we found F/O Sullivan. As we could see the others in the distance, I fired my pistol three times, completely captivating the natives.

It rained for thirty hours continuously after we arrived. The natives were very friendly, offering us all kinds of food, most of which we refused.

When Ozbolt and Powers joined us, while I was painting their scratches with iodine, the headsman's wife asked me to fix some sores on her arm, so I painted then until they became the color of her skin, and she thought that I had cured here. When I gave her some salt tablets for her goiters, the headsman got down on his knees and salaamed three times, then brought other patients who I gave salt and Benzedrine tablets. The guns the natives carried from Mausers, Luggers, Belgium Brownings, Lee Enfields, to an old gas pipe rifle, and one old gangster type tommy gun.

We started walking Southwest, keeping to the ridges as much as possible, as the people in the more populated places slowed our progress, finally reaching a Chinese Army Outpost, and the next day going on to Yen-Yuan. All along the road, the more intelligent looking people seemed honored by our presence and tried to keep us with them.



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The whole crew, which had been reunited at Yen-Yuan, started riding and walking toward Hsichang under the care of a Chinese Army guard. This took five days, spending the nights in remount stations and a mission. The remnants of bridges on the way gave proof of a highway many years old. Two large rivers were crossed by boat on the way.

We travelled by C-46 to Kunming, stayed there three nights, caught an ATC ride to Hsincning, truck to A-3, and B-29 back to Dudhkundi.

More sugar, salt and tea tablets could be included in the jungle kit, and perhaps every man should be compelled to add a toothbrush, large cake of soap, pair of socks, mosquito repellant, insecticide, and a couple of K-rations before he takes off. They will be a regular part of my jungle kit from now on.

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* HEADQUARTERS
462ND BOMBARDMENT GROUP
Office of the Intelligence Officer MWMcD/bhl

APO #220,
29 August 1944.

SUBJECT: Narrative of Ditching B-29 Aircraft Number 42-6263.

TO : Commanding General, XX Bomber Command, APO #493, %P.M., N.Y., N. Y. ATTENTION: A-2, Escape and Evasion Officer.

1. Submitted herewith is the narrative of Combat Crew members experiences in the ditching of B-29 Aircraft #42-6263, on 8 July 1944, while on a cargo flight from Piardoba Army Air Base to the Advanced Base in China.

2. Loading list for the Aircraft on this flight was as follows:

| | | |
|---|---|---|
| Dock O. Waller | Captain | Pilot |
| David F. White | 2nd Lt. | Co-Pilot |
| Walter R. Russell | 1st Lt. | Navigator |
| Edgar E. Hammond | 2nd Lt. | Bombardier |
| Arthur B. Tuttle | 1st Lt. | Flt Engineer |
| Don F. Carter | S/Sgt | Radio |
| Edward L. Swart | S/Sgt | Radar |
| Alden G. Huisjen | T/Sgt | Senior Gunner |
| James M. Lynch | S/Sgt | Right Gunner |
| Francis H. Iles | S/Sgt | Tail Gunner |
| Jennings, | Sgt. | 331st Service Squadron |
| Graffious, W. K. | W/O | 331st Service Squadron |

3. Three (3) crew members lost their lives by drowning. The bodies of Staff Sergeant Francis H. Iles and Staff Sergeant James M. Lynch were recovered. To date nothing has been heard from Staff Sergeant Lenard L. Anderson and it is presumed that he too drowned since fellow crew members report that he was unable to swim.

4. Narratives of individual crew members are as follows:

a. Captain Dock O. Waller, Pilot.

Normal take off was made from Piardoba Army Air Base at 0758 on 8 July 1944, in Aircraft #42-6263, and course for first leg of hump mission begun at 2,000 feet. At 0903 a climb was begun in order to clear the Shillong Hills. The flight plan was to level off at 8,000 feet. Just after beginning the climb the right scanner reported black smoke coming from number four engine. Climb was continued with scanner watching number four engine closely and during the climb the smoke decreased in density. During the climb there were heavy gas fumes in the front compartment of the aircraft and investigation showed that the front bomb bay tanks were siphoning. When 7,500' altitude had been reached the right scanner reported that #4 engine was on fire.

*XX Bomber Command Walk-Out Report, B-29 Combat Crews, through September 1944 in History of the XX Bomber Command Fourth Phase, Historical Study Number Two, "The Transport Project" Supporting Documents.

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I immediately got the course for Piardoba from the Navigator and began turning to it while the Engineer was using the fire extinguishers on the engine. After both extinguishers had been used the engine was reported still on fire by the Engineer, Right Scanner and Co-Pilot, Bombardier and Left Gunner, who was riding as assistant to the Engineer, bailed out of the nose wheel well. The bomb bay doors were opened for the gunners and I believed that all of them went out this way. The tail gunner was, as far as I know at present, riding as right scanner. There were two passengers riding in the gunners compartment and I presumed that they jumped from the bomb bays as well. Just after the third man had jumped out of the nose wheel well the Engineer reported that the fire was out. Bail outs were stopped immediately, at this time only four remained in the aircraft. They were the Radio Operator, Navigator, Engineer, and myself, the pilot.

I continued on course for Piardoba but was losing altitude at approximately 200 or 300 feet per minute while travelling at an airspeed of 43 inches and 2,400 rpm. Two attempts were made to feather the engine but each time the propeller ran away. I did not salvo the bomb bay tanks because I was afraid to risk spilling gas in the bombays with the fire on the ship. At 0940 it became apparent that it would not be possible to reach Piardoba so the course for Kurmitola was begun as this was the nearest base. When about thirty miles from Kurmitola and at 1,000 feet altitude it was apparent that I would not be able to reach that base. I informed the remaining crew that I was going to ditch. For the ditching a lake directly on course was chosen. For the ditching the Navigator sat in the Co-Pilot's seat and the Radio Operator sat by the Engineer.

Just before we actually hit the water it was necessary to put the turbos full-on in order to pull over trees between the plane and the lake. A power approach was made with power on until just a second before the actual impact. I made the approach so that the initial contact would be with bull rushes in hopes that this would cushion the aircraft and there would be no bounce. There was no bounce nor any sudden jerk as the aircraft hit, but a decisive slowing up which was not forceful enough to pull anyone from their seat. Neither of the four of us received any injury. We crashed at 1005.

After the aircraft stopped we immediately got out, carrying nothing with us. Since the front lower turret had given way the forward compartment was filling up rapidly and it was impossible to return for anything. Not only was it impossible because of the water but there was also heavy gas fumes. We pried open the life raft doors and inflated both rafts. Taking the Navigator with me I went in to shore, leaving the Engineer and Radio Operator in the other raft to guard the ship which was slowly sinking.

On the shore we were met by natives who served us tea and food. They produced a student named Mihr Lalsahah who could speak English. He told us that we were at a place called Khana and that he would arrange boat transportation to the nearest railroad. Sergeant Carter, Lieutenant Russell, Lieutenant Tuttle and I walked with the native student to Matkoha, which was approximately twenty minutes from Khana. Here he arranged for a boat which took us to the railroad at Karoid, charging us ten rupees for the trip. I offered the student a gift of money but he refused stating that he was delighted to be of service to American airmen who were helping India. The student also made arrangements with the local police of Pakundia Police Station to guard the aircraft until myself or someone else returned to de-



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troy it.

We arrived at the railroad at Karoid four hours later and proceeded to Kurmitola. Upon arrival there I called XX Bomber Command and gave details of the accident. I was told to await instructions. On the following day at 1100 Major Burns arrived in a B-25 Aircraft and decided to bomb Aircraft #263. Two bombing runs were made and 8 X 500 pound bombs were dropped with unsatisfactory results. Arrangements were made with the Service Group at Kurmitola to send a salvage crew to destroy the aircraft. Later in the day we returned in the B-25 to Piardoba Army Air Base.

b. 2nd Lieutenant David E. White. Co-Pilot.

I bailed out of aircraft #263 through the nose wheel well and saw four other chutes in the air but went into the overcast and lost track of them. I left the overcast several hundred feet from the ground and observed the entire area to be covered with water. I began loosening the chute harness and had unstrapped one leg strap and was undoing the other when I hit the water. I had no difficulty in getting free from the parachute. I undid the jungle kit and it floated to the surface. There was a native boat about one hundred yards away and I called several times for help. When they ignored me I placed the jungle kit under me for support and started to swim. No one else had landed near me. I swam about two hundred yards to a bamboo pole sticking up in the water and hung on to it. I was able to pull myself up the pole and saw more native boats. When I called for help they rowed out to me. At first they seemed reluctant to take me into the boat but I climbed halfway in and held on and then they helped me in. I could see a chute some distance away and by using gestures persuaded them to row to it. We pulled the chute from the water but it was empty and no one was in the water nearby. We searched the area for quite a while and saw another chute. We started to go to it but before we could reach it another native boat had arrived and I saw them pull another man from the water. We then rowed to a small island, no larger than 100 feet long and 40 feet wide, upon which were five native huts. The natives were extremely tall with mongaloid features and wore chin whiskers. They were very friendly and gave me leaf cigarettes. After two hours another boat brought in Lieutenant Hammond and Sergeant Huisjen. I opened my jungle kit and found one compass filled with water and useless, however the second compass functioned after being shaken out. I intimated by gesturing that we wanted to be taken to the west. The natives however did not understand. Soon a native from a nearby island arrived who spoke a few words of English. I pointed to the west and made train noises. He shook his head and said, "No" and kept saying "Police Station". He put the three of us in his boat and after two and one-half or three hours we came to a larger island and the village of Tahirpur. Here we were met by some territorial policemen who took us to their headquarters. There were no communication facilities available. The police said that they would get a boat to take us to Sunamganu. Meanwhile the police heard that three other crewmen had been lately picked up on the other side of the lake so we decided to wait until they arrived. At about 1600 Sergeant Swart and Sergeant Jennings and Warrant Officer Graffious arrived. At 1730 we left by boat for Sunamganu. The boat was propelled by long poles and the trip lasted nearly twelve hours. We arrived at 0400 the next morning. Here we were met by a Rice Control Officer and some other local officers.

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We sent a wire to Sylhet. At 1300 the following afternoon a C-47 came from Sylet and circled. We stood out in the yard about five yards apart so that they could count us. They dropped a handkerchief secured around a message telling us that a rescue party would come. Shortly after a British Major and Lieutenant came to the building and told us that we could use their motor launch to go to Sylhet. We decided to accept the offer and wired Sylhet to meet us at a ferry landing just above Sylet. We arrived at the ferry at 0300. We waited until 0800 and then crossed the river. Lieutenant Hammond and I started walking to Sylhet and after having gone about five miles we were met by a Military Police Captain and a Sergeant in a Command Car. We returned and picked up the other members of our party. At Sylhet the Intelligence Officer told us that two flat bottom gas boats had gone searching for us. I accompanied a search party in a C-47 aircraft to the scene of the ditching and went again the following day. We found nothing. We were then flown to Tuzgon where we were in turn flown to Calcutta. From Calcutta we returned to Piardoba by train - elapsed time from accident was eight days.

c. 2nd Lieutenant Edgar E. Hammond, Bombardier.

I left the plane through the nose wheel door and had no difficulty clearing any obstacles. When I came through the overcast I saw the water and started to unbuckle the chute straps. I easily got free from the chute. There were no boats in sight and I started swimming toward an island about one mile away. After swimming about one-half hour I became exhausted and tried to remove my clothing - succeeded in getting off one shoe. The next thing I remember is being hauled into a boat. When I came around I discovered that I was on an Island. From this point my experiences parallel those of Lieutenant White.

d. 1st Lieutenant Walter R. Russell, Navigator.

I did not parachute. Following the ditching I crawled from the pilots window. I encountered difficulty in releasing the life raft but finally two of us were able to get free. I went ashore with the pilot as related by him.

e. 1st Lieutenant Arthur B. Tuttle, Flight Engineer.

When we prepared to ditch I fastened my safety belt and held the Radio Operator, Staff Sergeant Carter, so that he would not be thrown about in the crash. On impact with the water the lower forward turret was pushed up into the cabin making the compartment very dangerous. I had removed the engineer's escape hatch just prior to ditching. I climbed out on to the fuselage. The cabin was filling rapidly from the turret rupture and there were strong fuel fumes. The plane settled very slowly. I removed the left life raft and inflated it. There was no equipment in the raft and it was not tied up to the aircraft, however the water was calm and it did not float away. I pulled the raft around to the tail gunner's position and found the escape hatch closed. Captain Waller left me to guard the plane. More than one hundred natives had come to the scene, however they made no attempt to board the plane. I made two or three unsuccessful attempts to go back into the aircraft through the submerged hatch. After the aircraft had settled until only the tail fin was visible I got some short boards from the natives and paddled to shore about 600 yards. After



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making shore Sergeant Carter and I walked to the home of the English speaking student where we joined the others. From this point on my experiences parallel those of Captain Waller.

f. Staff Sergeant Don F. Carter, Radio Operator.

I was with Lieutenant Tuttle throughout the accident. I have nothing to add to his narrative.

g. Staff Sergeant Edward L. Swart, Radar Operator.

When ordered to bail out I left the aircraft from the rear door. When I landed in the water I quickly got free from the parachute. I unfastened the jungle kit and used it as a float. I swam about for approximately forty-five minutes and was then picked up by a native boatman and taken to an island where I found Lieutenant White and the others. From this point on my exoeriences parallel those of Lieutenant White.

h. Staff Sergeant Alden G. Huisjen, Senior Gunner.

When I bailed out I saw four chutes in the air below me however I lost sight of them when they went into the clouds. I fell for about eight minutes and when 200 feet from the water I broke out of the overcast. I could see three chutes in the water, however I did not land near them since a strong current of air swept me far out in the lake just prior to landing in the water. When I saw the water I undid both leg straps hence was quickly free from the chute once I hit the water. I started swimming without trying to remove my clothing but became very weary and succeeded in getting all of my clothes off. I squelched a panicky feeling and swam toward an island, it is estimated that I was in the water for an hour. I alternated swimming and floating and remained in good shape. Finally a native dugout appeared but they seemed afraid to take me into the boat, but when I held on and kept lunging in they aided me. I conveyed with gestures that there were others somewhere in the water. We finally saw a parachute and rowed to it and found it to be my own. Since we could see no other chutes we went to the island where I joined Lieutenant White and from that point on my experiences parallel his.

5. Interrogator's notes.

a. During the interrogation crew members made the following suggestions and significant comments.

(1) All natives after overcoming a momentary reluctance were extremely helpful and sympathetic. The boatmen evinced great interest in personal adornments, watches, rings and crash bracelets and it is suggested that crew members be advised to leave all trinkets behind. While Lieutenant Hammond was in an exhausted condition the natives tried to remove his rings. While in the boats the natives inferred that they be given watches and bracelets.

(2) Lieutenant Russell encountered great difficulty in freeing the right life raft and states that he alone could



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not have released it. The grip is so tiny that it does not permit a firm grip and slips through the fingers. He suggests that a four or five inch grip with a bar be devised. Lieutenant Russell and the pilot also concur in the suggestion that a remote life control release be installed near the pilot or co-pilot seat, enabling them to release the raft as soon as the plane is down. It was fortunate in this case that the plane remained afloat for a considerable time.

(3) Several remarked that they had not known previously that the jungle kit makes an excellent life preserver and is capable of keeping one afloat for a long period.

(4) The pilot, Captain Waller, suggested that the 'ditching' proceedure be changed thus:

(a) Eight men sit in the front pressurized compartment ahead of the lower forward turret, on the floor with their backs to the nose of the plane.

(b) Pilot use power-on on all engines on approach and try to as nearly as possible make the contact point a power-on stall. This will allow the pilot to choose the exact moment of contact.

MALCOLM W. MC DIVITT,
1st Lt., Air Corps,
Interrogating Officer

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* 792ND BOMBARDMENT SQUADRON
Office of the Intelligence Officer
APO 493, New York, N. Y.

18 September 44

SUBJECT: Report of Captain E. E. Winkler. (Pilot of A/C #356)
(Date of accident - 25 August 44)
TO : Commanding Officer, 468th Bomb Group, APO 493,
ATTN: Group S-2

1. The following is the report of Capt. E. E. Winkler from the time of bailout till his return to A-7.

"I bailed out about 0700 at 17,500'. I was knocked out just after pulling my rip cord. I had my canteen in my left hand and believe it hit me on the head when the chute opened. When I came to I was sitting on the ground. I called out to F/O Thompson who answered me. Instantly I heard some Chinese voices. I knew I was in Lolo country and my first instinct was to hide. Looking around I saw six natives coming toward me line abreast about four feet apart. I yelled 'Ding Hoa' and held up my thumb but it made no impression on them. I called to Thompson and told him that I was going with these fellows and he didn't have to show himself if he didn't want to. I went back and got my parachute. We started down the road and as we came around a bend we came upon F/O Thompson standing in the path. I talked with Thompson and neither of us were sure whether these people were Lolos or not. Natives were very curious. They opened my jungle kit several times and I had to close it and try to tell them not to open it. As we walked on, the native carrying my parachute got far out in front of everyone and finally started away in a dead run. I never saw him again. We arrived at a village at about 1000. There we met the real Lolos. They were much larger than the Chinese, much more clean cut and they usually wear their hair tied in a knot on top. Natives or Lolo slaves by waving etc. told us that there were three more men coming down the hill into the town. We went out to meet them. Sgt Griffith came in on a donkey. He had a sprained ankle. Lt. Stover and Hardin were walking. We came back into town. While we were standing around talking we noticed a Lolo in a bright blue uniform talking to other Lolos apparently about us. We found one man who could read the Pointie-Talkie. We asked him how far it was to Lo-Shan. He said that Lo-Shan was over the mountain about two or three days away. Lt. Stover had a cut chin caused by his gun flying up and hitting him in the face when his parachute opened. We redressed his cut, and decided to try to walk to Lo-Shan. Sgt Griffith was still on the donkey so we tried to persuade the owner to go with us. He refused and we gave him some money and still he refused to go or to sell the donkey. Finally I pushed him along forcibly and we started for the river near the village. About 1400 we met a guerrilla chief and a Chinese soldier. The guerrilla chief told us he had been sent to get us and was going to take us to his village. We had no food so we ate raw corn from the fields enroute. About 1930 we reached the guerrilla chief's house, which he called Army Headquarters. It was a standard Chinese house,

*XX Bomber Command Walk-Out Report, B-29 Combat Crews, through September 1944 in History of the XX Bomber Command Fourth Phase, Historical Study Number Two, "The Transport Project" Supporting Documents.

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one large room in which the livestock were kept on one side and beds for the members of the household on the other side. We slept in a small anteroom and the mosquitoes were very bad. In our small room was a wooden coffin which contained the body of a relative of the guerrilla chief. The relative had been dead two years and later it was explained to me that no burial was accomplished because the chief had not found a suitable place for burial. The next morning the father of the chief and several other natives set out to find Sgt Stone and Schriner who were in the hands of the Lolos on the other side of the mountain. They borrowed our knives. At 1800 that evening ex-General Yung, two officer gendarmes and 12 enlisted Chinese soldiers arrived. The people of the village paid him great respect. Some would kneel down in front of him and kiss the ground. He took out a handful of bills and gave money away to the natives. The General was very polite and kind to us. He brought us hard boiled eggs, chicken etc. They cooked the chicken head, entrails and all. It wasn't very tasty but at least it was food. Great crowds came to see us the next day. The General was always out there to greet them. He gave them some kind of a political speech. There must have been at least a thousand people that day to view us. They were all very curious and were very interested in the fact that we had hair on our arms. All the time I had been laboring under the delusion that the officer gendarmes were the people to talk to but I found out later that the General was the man to take my troubles to. From the time the General arrived till the time we left him at Fulin there was a constant guard kept around us even at night, when we slept. The buildings had cement floors which served as our mattress. It was too much for Lt. Stover and F/O Thompson so they went outside and went to sleep in the hayloft. The next morning when they awoke there were at least eight Lolos asleep all over them. One Lolo had crawled in between the two officers and was snoring away. Lt. Stover and F/O Thompson slept inside after that. Later in the afternoon of the third day Sgt Stone and Sgt Schriner were brought in. Sgt Stone was in pretty bad condition; his rib was broken and hip skinned and the inside of his leg was skinned from the thigh all the way to his ankle. Sgt Stone's leg caught on the escape hatch as he was leaving the airplane. The General said that we would leave in the morning for Fulin. We didn't sleep well but awoke the next morning in good spirits at the prospect of going on to Fulin. Sgt Stone had been in constant pain all that night. I wanted to get him to a doctor. Mr. Wong, a Lieutenant gendarme in Fulin, came to me and said that we would not leave today, but tomorrow. I became pretty disgusted and wanted to get the two injured men to a doctor and everybody else had the "G.I.'s". He said that many people were coming in to see us. I didn't know until later that the General had ordered 500 Lolos to come and see us that day. I went to Mr. Lee Yeng Ho, a gendarme who could speak a little English and told him that if we didn't leave that day, the General would get into serious trouble with our government. It made no impression on them so we packed our things and started down the road carrying Sgt Stone and Griffith. Mr. Wong came up and told us that the General had changed his mind and that we would leave after breakfast. We left about 0800 and soon reached a river with a very strong current which at times was as wide as the Mississippi. We had to ford the stream at least 10 times. Our journey of 10 miles took 11 hours. On the way we stopped at a house belonging to a friend of the General. There we were given eggs, pears and some walnuts. We reach Fulin about darkness. It was a mile from the river to the city so the General had horses and sedan chairs waiting for us. On the way to the city, Lt. Hardin's horse became a little friskey and threw him to the ground.





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Lt. Hardin walked the rest of the way. We were taken to the General's house where we spent our time until the arrival of Col. DePass Jr. from Chungking. There were in the meantime several personal incidents such as Lt. Hardin's birthday. The General broke out some of his best wine and needless to say a good time was had by all. Nothing else of importance happened."

/s/George J. Steinmetz
GEORGE J. STEINMETZ
Captain, Air Corps,
Intelligence Officer.

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*LT. MONTGOMERY'S TRIP

Last month, Lt. Montgomery had an experience that is well worth the telling. When he arrived in India, he recalled that a certain Maharajah was a good friend of his father. He wired this ruler of his arrival, received a wire inviting him to be a guest at the palace, and received permission to go.

Lt. Montgomery was the palace guest of his highness, the Maharajah of Holkar, Ruler of Indore, India. He was the guest of honor at a special polo match between two Indian teams, and as guest, played one chukker as forward.

Later, the party went hunting, riding in a "matched pair of Ford V-8 station wagons". These were equipped with especially-built gun racks, spotlights, food chests, hot and cold tea, etc. The hunters sat in one station wagon while beaters drove the game past them. "It sure was de luxe hunting", said Lt. Montgomery. Incidentally, the Maharajah has the distinction of having shot the largest deer in Indore; a record with 38-inch horns.

They shot all the game they desired in this teakwood jungle hunting preserve. Lt. Montgomery got 13 animals, 1 crocodile: a tiger, deer, wild boar, blue bull, gazelle, and antelope. The Animals are being mounted and will be sent to Lt. Montgomery's home in Beverly Hills, California, as a gift from the Maharajah. He is also having a suitcase made of the blue bull hide. The bull is about the size of our elk. On this trip, Lt. Montgomery had the thrill of riding in a howdah atop of an elephant.

His highness is the Ruler of Indore, the most progressive Indian state. He lives in the only air-conditioned palace in India. It contains two complete kitchens: one for American cooking, one for Indian cooking. Her highness, the Maharanee, personally cooked American pancakes for breakfast, serving them with honey and "Log Cabin" maple syrup. The palace grounds are immaculately maintained, and are most beautiful. His highness has his own airport and a small fleet of planes. The modern airport was offered to the USAAF, but because it is out of the usual military routes, is serving as an emergency field.

The garages contain a mere 76 cars, mostly American makes. When they went for a drive, a "crew chief" follows discretely behind in a Ford V-8, to change "tyres", or do other emergency repairs if needed. The Maharanee drives her own 2-seater car, a mere 25 feet long.

When the Maharajah goes hunting or driving, he always carries a large bag of silver coins. Anyone may approach him with a complaint, which is heard, and a decision given. Then, he brings two handfuls of silver coins from the bag, gives them to the supplicant. Every child who comes near him also receives coins, which, by the way, are apparently silver rupees.

Other palace guests were: his highness, the Maharajah of Gwalior, and his highness, the Maharajah of Dewas, Senior.

*Ninety First Fighter Squadron, Eighty First Fighter Group, Outline History for May, 1944.

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The present Maharajah lives in his own palace; each ruler builds his own edifice. However, for state functions, he uses his grandfather's palace. This is located a short distance away, is a one-story structure, built on the curve of a river, extending a total of one and a half miles.

Indore is a very rich agricultural state. It produces cotton, grains and tea, being green 4/5ths of the year. It is highly electrified, has the best paved roads in India. Indore is the only Indian state that was never conquered; it became a part of the British empire by treaty. As a result, it pays only nominal taxes; a few deer heads and other minor token payments per year. It also is the only Indian state possessing the right to appoint its own ambassadors, but does not bother.

Money, apparently, is the least of this ruler's worries. When Lt. Montgomery inquired the cost of any object, the reply was never in rupees, but in "lakhs". A "Lakh" is worth $30,000!

As the time came for Lt. Montgomery to depart, he was taken to a special entertainment which promised to continue beyond his time to leave to catch a returning transport plane. The Maharajah reassured him, and when the affair was over, sent him to his destination in a fast car, convoyed by another. These cars made a round trip of over three hundred miles merely because the Maharajah wanted his guest to enjoy an extra half hour's entertainment!

"All in all", said Lt. Montgomery, "it was the most unique and exciting experience I have had in my life. It was the first leave I have had since before Pearl Harbor." The Maharajah offered Lt. Montgomery a position as his Air Aide-de-Camp after the war.

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* LOLO REPORT

Prepared by - Frank J. Mullen - Capt AC
AGAS-China

REPORT ON TRIP THROUGH THE LOLO COUNTRY IN WESTERN CHINA
(FROM LATE JUNE 1944 TO 26 AUGUST 1944)

"Lolo" is a derogatory remark which the Chinese have tacked onto a people, as indicated on the 1:1,000,000 International Map of the World, as Lolo dominated country.

Calling a person a Lolo is akin to calling a Negro a "Nigger" or a Chinese a "Chink".

Literally the word Lolo is supposed to mean "Basket". The people hung the cremated remains of their dead in a basket in trees - hence the supposed origin of the word.

The people are a tribe of the Ee people of China of which there are many branches.

In a former report we wrote about the Baiyees. This one is about the so called Lolos or Ee-wrens - "Ee" means the people and "wren" meaning "Men". Some place else you may see them mentioned as Ee-Jias (Ee-Jaw) or Ee-Jiaos (Ee-Jows). But for matters of simplification we will call them "Ee-wrens" and will refrain from calling them Lolos.

As we, James Chen, Secretary of AGAS-China, and the writer, Capt. Frank J. Mullen, are trying to catch up with our reports we are writing this on the trail - hence the dates may be somewhat out of gear - however, the substance of the story will be correct.

Late in June, AGAS was informed that a B-29 crew was in distress in Sichang (102-18E:27-53N). It is on the southwest edge of the Lolo Independent country that is unexplored and is a source of great worry and concern regarding getting men back safely in case they have to bail out or crash land.

The Ee-wren is supposed to be a pretty bad customer and efforts as you will see later in the report are being put forth to see what results can be accomplished, in working out a deal with them, to return, to safety, stranded airmen.

The 14th Air Force furnished a C-47 and we flew to Sichang and brought the B-29 crew back to Kunming, which had crashed.

While in Sichang, which is the Western Field Headquarters of the Generalissimo under Gen. Chang Teh-luen, we left two E-10 Sustenance Kits with Sgt. Telles who is in charge of 4 EM of the 10th Weather Squadron stationed there and informed him that at anytime it was necessary to aid either airmen arriving in Sichang who had bailed out or crashed or send rescue details to get them, the contents of the kits were to be used for that purpose.

* History of the XX Bomber Command Fourth Phase, Historical Study Number Two, " The Transport Project" Supporting Documents.

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We also called on Gen Chang and between us we worked out an arrangement whereby he would furnish us written Lolo so we could develop a "Pointie Talkie" - we are then to furnish him with 20,000 copies that will be distributed throughout the Lolo country - then any distressed airmen can show their copies and possibly the two combined will do the trick.

Gen. Chang is in charge of the Central Government troops in this part of the country and under him is a Commander Dunn located at Kun-chou-yun near Luku (100-15E:28-15N) whose job it is to keep the Lolos from causing too much trouble. The General thinks properly handled the Lolos will be our friends - although he frankly said that the Chinese have very little influence over the Black Lolos. The White Lolos (purely terminology) are pretty good people and no trouble will be encountered there.

West of Sichang stretching to Lilien (Lee-jian:100-10E:28-55N) is also Lolo country. The people are tame and are a friendly lot as we later found out.

There are Lolos all over China - in fact there is a tribe of them on Formosa although like all tribes out here many have moved out of their part of the country but these are still concentrated areas and those parts are what this report is about.

As you move west and southwest of I-Pin (Suifu: 104-45E:28-45N) the mountains are in dominance and it is in these hills the trouble with the natives will be encountered. The Taliang Shan (Da-liang Sun) is a high range of mountains called by the natives "The Hills of the Storms" and it will be necessary in this section to negotiate for the safe return of our men . It is unsurveyed country and little is known about it - God willing we may be able to throw some light on a portion of it.

A few days after returning to Kunming we were informed by the 20th B.C. that there was a crew in distress at (101-15E:27-45N) and also that three men of another crew were walking into Sichang. The former was later proved to be Capt. Mann and Crew of ship #046 of the XX B.C. and the latter was crew #814 including ten alive and one dead. The information was sent by the CAF at ~~Sichang ten alive and one dead. The information was sent by the CAF at~~ Sichang. AGAS made arrangements with the CNAC (China National Aviation Corporation) to fly us to Sichang and once again we were on our way.

We took with us quite an additional lot of rescue equipment as we intended heading west from Sichang and set up caches of food and medicine along the route taken by the 20th B.C., ATC and CNAC from India to Chengtu. Upon our arrival in Sichang we were informed the crew reported at(101-15E:27-45N) were actually one degree farther east which put them in the heart of the Lolo country.

Two days before we again arrived at Sichang, Gen. Chang sent 12 Chinese soldiers accompanied by two U.S. EM of the 10th Weather Squadron to escort this crew to Sichang. On checking where he received his information about the crew the General said that a Lolo runner had come in from Chaochiehsien (102-55E:28-15N) telling him a relation of his had been informed that a crew of seven men ( one dead) had landed on a 10,000 ft. peak in the neighborhood of Samah (103-10E:27-55N) and they were being escorted to Chaochiehsien where a Chinese telegraph and radio are located.



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The EM took large quantities of things from the E-10 kits to aid the distressed men and the General so it was reported sent with his men 50 bolts of cloth and many cakes of salt as a reward for the Lolos who had and were aiding the men.

Also he had printed (see Enclosure #1) on an old Chinese stone press a message to be distributed along the way about the incident.

On our visit with the General a few days previous we asked him to reward the Lolos who helped any of our men immediately on their arriving in Sichang and he followed the suggestion by sending in the cloth and salt. Our idea is if the natives know they will be rewarded the possibility of having men return to safety will be almost 100% and if we can get them competing for the reward there will be a real race to get to the distressed men and the men will be the eventual benificiaries of the plan.

We felt the crew just mentioned were in safe hands and then we turned to the problem of the three that we were informed were part of a crew of seven that bailed out south and west of Sichang in Tame Lolo country.

Gen. Chang had sent runners to escort them into Sichang and to order the village leaders and magistrates to send out searching parties to look for the four men unaccounted for.

We were informed a message had come in saying money was needed in Yenyuan (101-30E:27-8EN) where the men were located to buy them food and to take care of them on the way. We informed the General through Maj. Young (the Chinese Air Force Stationmaster in Sichang) to send whatever was needed to get the men out safely.

Orders were left to get in touch with AGAS, Kunming to have the men flown out upon their arrival in Sichang and we proceeded to Likiang or rather Paishi (Bay-she) which is the airport 10 miles north of Likiang. Here are stationed four men of the 10th Weather Squadron and 6 men of the AACS under Command of Lt. Miles.

We left with them two E-10 Kits and instructed them what to do with them.

Lt. Miles had a couple of men (Sgts. McCann and Miller) who accompanied us on the trip farther west by foot.

We hiked into Likiang and stayed a couple of days with Rev. James Andrews and his family, British Pretacostal Missionaries who have lived in the country a great many years.

Confined within the area of the town are two German Lutheran missionary families - the Starrs and the Zerrings. They were formerly stationed in north of Likiang and the Chinese forced them to come to Likiang to keep an eye on them. Both the British and the Germans have been of help to the Americans at Paishi and to men who bailed out in that part of the country. Mr. Andrews has been acting as interpreter for the Americans which has put them in an embarrassing positions - he is British and a missionary and the Chinese do not relish his being in on all things between them and the Americans - he has a superior attitude and is quite a brow beater and often it has reacted against the Americans - we are recommending they have their own interpreter - Andrews as well reports all activities to the British Consul.



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Many thoughts about the British and the Chinese not getting along so well have been theoretical to some members of AGAS so we accepted Mr. Andrews' suggestion that he accompany us on our trip west - it would give us a practical answer to many questions regarding the British and some British missionaries. (In this respect Andrews is a religious fanatic outwardly but has done a good job of feathering his own nest at the hands of the ignorant natives and signs indicated he is held in ill repute by many of them. Where the direct opposite was true of British missionaries - the Methodist - we met later on in our travels.)

We called on Mr. Lee, the Magistrate of Likiang, a graduate of the University of Peking - a very learned and helpful person. He informed us there was large airplane a few days march west which had destroyed itself on top of a mountain and there were fifteen bombs in it.

Some natives had brought in some flying clothes and some maps but we could not identify the plane from them. As we were still looking for plane #261 of the 20th B.C. which has never been heard of since it left its base in India on the 8th of June for China. We felt maybe this was it. Lee sent a man along with us who had been at the plane - he knew nothing about describing it except it was big silver one.

We obtained horses and started west. Enclosure #2 is an overlay of the trip recorded in this full report.

The first night out we stayed in a Lhamasary that reports directly to Lhasa. The monks are a dirty lot like practically everyone else in this part of the world but they were a pretty courteous bunch. They escorted us through their temple and showed us their board backed books which are great treasure itself - they refused to sell or give us one however.

Once a year representatives visit here from Lhasa for prayers. The rest of the year nothing of any consequence happens although youngsters are being taught Lhamaism by the elders.

We slept in an altar room and at daybreak were awakened by the crashing of cymbols and the intonations of the monks at prayer.

About 2/3 a day Journey farther west we left the trail for about a half a mile to inspect the wreckage of a C-46 which had crashed months before. The crew had all bailed out safely. Very little was left of the plane and its cargo of stainless steel was completely buried in the wreckage.

Previous to our leaving Likiang a runner had come in informing us that a Lt. Wesselhof of a Geodetic Mapping Squadron was ill in Lanping (99-20E:26-26N) with myelitis (infantile paralysis) and asked something be done to get medical help.

With Miles' aid we wired (in the clear) through CWAC radio stationed in Likiang and the final outcome of that story is the boy was flown out in an L-5 piloted by a boy who had to use a pump rigged up by the doctors who eventually reached Lanping in time to save Wesselhof's life - he is now on an iron lung in India. The pilot has been recommended for the D.F.C.- in addition the medicos who rigged up the apparatus or artificial respirator, in the hinterlands deserve a commendation as well.



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We reached a town of Shiku (Shi-goo) (26-55E:26-56N) on the Yangtze Kiang (Yang-z Jang). Kiang means large river. It was fully-thirty feet higher than usual and is quite a roaring sight - "Liquid History as it were." The river flows down from Tibet and makes an 90 degree turn in a few feet and starts north.

Shiku means "stone drum" and greeting you is a large stone in drum shape, encased in a pavilion, as you enter the city it has many myths surrounding it. If something terrible is going to happen to the village it opens up - so far the village has been in good shape or favorable repute with the Gods.

Living at Shiku is a Brooklyn Pentacostal missionary Miss Denice - a humorous old maid and an unusual character. We left medicine and rations with her and asked her to assist any stranded fliers and any expense she was put to would be reimbursed immediately upon her informing us the amount.

The rainy season is on in China and our trip was a pretty rough one. We were wet most of the time and the trails were slippery and mighty disconcerting - the streams were full and crossing them was a struggle: as we were so wet constantly we plowed on through them without removing our shoes or clothes.

We had quite a nondescript gang of guards. Over 60 Mo Sos were detailed along the way to guide us and protect us from "all harm".

The No-Soslive in the hills in Log Cabins. They have practically nothing in this world. Practically naked - they still use cross bows and poisoned arrows and are a lazy shiftless gang. Despite this they are harmless and they will do no harm to white men.

After two days we reached a spot in a valley opposite the mountain on which the "Big Silvery Airplane" was wrecked.

After making three camps - one at the foot of the mountain - one half way up and then one at the plane which took two full days to reach. We found the wreckage of a C-46 #124754. Instead of 15 bombs, we found 5 - 250 lb. ones, and a number of oxygen tanks.

When we returned to Kunming we found the ship was one which had crashed in January with the whole crew, safe after bailing out and, returning to duty.

We instructed the natives as we moved westward to hurry a runner to Likiang or if they were close to Lanping to there in the event any airplanes crashed and to escort the men to safety.

This part of the world is really desolate and men in distress here will suffer from lack of food and difficult terrain.

After another day's march westward we had to turn back because the streams were so high that we could not cross one of the bigger ones.

Fortunately we started back east when we did or we may have been in there for a week or so. Small streams which gave us no difficulty going west had swollen to practically impassable depths.

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We again reached Shihu - parted company there with Andrews and the two EM and headed south.

Mr. Andrews was disconsolate to some extent because we refused to permit him to handle American affairs - the period of time he has spent out here makes him feel he is the ruler of this part of the world and we had to call his attention that a missionary duty was one thing and that an American Army detail was another.

Our travels took us south to the Burma Road and then on to Yunnanyi where we caught a plane into Kunming.

Upon arrival there we were informed that crew #314 was still in difficulty and had not been returned to safety.

A few days preceeding this Lt. Ross Taylor of ACAS had gotten a C-47 from the 14th and flew to Sichang with a lot of equipment intending to parachute the stuff to the men if he could find them.

Weather around Sichang was "socked" in so he had to return with his mission uncompleted.

So once more we headed north - this time fully intending to run the story down why these men were still roaming and not back to safety. We flew out over the Yangtze and circled the country between there and Sichang to see if we could see them but we had no luck what so ever.

In Sichang we had a meeting again with Gen. Chang and his staff plus two men who were agents of the Chinese working with the Ee-wrens - one of these men, a fine fellow, Mr. Lee Shih-an, had been born in Leipo (103-40E:28-30N) on the edge of the Ee country and is a White Ee.

The outcome of this meeting was that we were to return to Kunming and from there enter the Ee-wren country from the south. Mr. Lee was detailed to accompany us - to act as an interpreter and at the same time check on conditions in the country from the Chinese standpoint.

We informed Mr. Lee that our mission was to set up routes so distressed airmen could get out of the country and to get the story about and locate crew #314. We further informed him we were not interested in any other factors and if he, on his own, got into political discussions or other things he was not to do it in the name of the U.S.A.A.F. or any other protective measures which cause reverberations about our mission. This he understood thoroughly.

We returned and on 23 July - Left Kunming at 1700 and arrived in Chanyi at 2130. (Follow story on the map)

The general contour of the country is similar to that encountered on the Burma Road. The road is good. Chanyi is a rail head and here all stuff is dumped off and carried north by dilapidated Chinese trucks.

We had to travel slowly because the roads were slippery and dangerous.

We carried with us our usual gear. Bed rolls, mosquito nets, tents, toilet articles et ceters.





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In the way of food we carried -

3 boxes C Rations.
3 boxes K Rations.
3 boxes D Rations.

Because we did not know except by hearsay, what is needed for travelling in the Ee-wren country we had many doubts regarding getting food.

For barter and presents we carried blue Chinese cloth (out of which the natives make clothes), candy, cigarettes, tobacco and medicines consisting of Quinine, Atabrine, bandages, Iodine Swabs, stuff for dysentery etc.

We started out with CN $0,000 and all the Chinese silver and Rupees we had.

To return to the trip - Chanyi had Chinese Hostels where we stayed. They are the poorest we have encountered so far.

Evacuees from the east are arriving there. At the Hostel was Rev. Theo Mikolon, A Lutheran Army Chaplain from Scranton, Pa., who was stationed in Kweilin. With him was Father Wm. Stern of St. Louis who one week previously was taken in the U.S. Army as a Chaplain on a civilian basis.

24 July - Drove to Weining in an interminable rain, accompanying us, as a passenger from Chanyi to Weining, was Rev. Keith Parsons, a British Methodist missionary who was going to replace Rev. and Mrs. Stone of the mission at Weining (the Stones are going back to England ).

We stayed with the Stones overnight. Jimmy Chen was suddenly taken ill and later at Chaotung he was placed in a Methodist hospital. We were informed he had Malaria.

Awaiting Rev. Keith at the Stones was a letter from a brother of his who is an internee in the Pootung Civil Assembly Compound in Shanghai. His brother was formerly a missionary in Hankow and for over a year has been interned. He indicated he is being treated well and has gained weight although in true British style he said he was "a bit bored". Preceeding his internment he, like all missionaries was permitted the freedom of the city - but as conditions got worse for the Japs all free men were put in camps.

As the Japs have not interned people over 65 the letter was sent to an old friend and she in turn sent it on to Rev. Parsons.

Jimmy Chen has a sister and two brothers in Shanghai and monthly letters reach him through the regular Chinese mail.

25 July - Rev. Parsons accompanied us on to Chaotung where we arrived at 1830. The road is narrow but despite the rains and landslides we had little difficulty.

Chaotung is the second large city of Yunnan Province - Kunming is the largest. It is situated in a large fertile valley. Unlike Kunming its streets are narrow and the whole place is quite filthy.

On driving to Chaotung the road leaves Yunnan Province at 104-15E:26-45N and runs through Kweichow (Gwei Jao) north, then north west and then again



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enters Yunnan at (103-55E:27-10N)

Ruling Chaotung and all the northern part of Yunnan is General Lung, the second son of Governor Lung Yun who runs all of Yunnan.

Gov. Lung is a Black Ee and here on hangs quite a story.

It is told throughout the Province that a certain king of one tribe of the Ee-wrens has a comely daughter whom one of Lung's sons wishes to marry. The king refused on the grounds that even though Gov. Lung is an Ee-wren but his is a pretty low one in the tribe and as such is not of high enough standing to merit the daughter of the king for one of his sons. This so inflamed Gov. Lung that his son (a Division Commander of the Yunnan provincial troops) sent in an army and aided a brother or cousin of the king (who is also a king) in doing a fairly good job of licking the obstreperous fellow in retaliation. This was the reason that crew #314 were taken to I-Pin instead of Chaotung - a difference of many days, as the king won't have a thing to do with Yunnan.

There are a few things stranded crews in the Ee country should know:

1. Never call the people "Lolos" - the word Lolo is a Chinese epithet and anyone calling them such may be slapped in the face. They are to be referred to as Ee-wrens or Ee.

2. Never mention as crew #314 did that they were from Kunming. Kunming is the stronghold of Gov. Lung who has been at war with many Ees (trying to stop the opium trade) plus also that - the sons army has warred with the desired wife's tribe makes the Ees very hateful of Yunnan in general.

Last year the little king who took the licking was a guest of the Generalissimo in Chungking and swore allegiance to the Central Government. (Lung's army are provincial or were until they recently merged in name with the Central Government)

Therefore, for all these reasons, instead of saying you are from Kunming say you are from Chungking, Sichang, or Chengtu or Suifu (Sway-foo which is now officially called I-Pin)

Name the closest place you are near so you won't be guided unnecessarily for days as crew #314 was just because they said Kunming instead of Sichang which was about 7 or 8 days from where they were stranded.

The Methodist Hospital in Chaotung (Jow-toon) is run by Dr. Luth. Also doing spiritual work there are a Rev. and Mrs. Steel and Rev. Ready. The latter has been in China for 30 years - almost all of it in Central China until driven out by the Japs. His stories about Jap atrocities especially toward the Chinese women are pretty vile.

The head nurse of the hospital is Miss Milner who was repatriated from Hongkong and returned from South Africa to China via India. Aiding her is Miss Hilda Hudson, an Irish girl whose fiance is Dr. Watt being interned in Stanley prison in Hongkong. Watt is permitted to write one postal a month of 25 words and Miss Hudson has heard monthly up to June from him via the I.R.C. Rev. and Mrs. Harrison, a Miss Harris and Rev. Wright who is located at Tungchwan (107-1/2:26-23N) are also a part of the mission.



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Capt. Mullen stayed with the Lyths.

Dr. Lyth has been in these parts about 10 years and had some knowledge of the Zee. We discussed with him the kinds of medicines he would carry if he was going into the country and we traded him much of ours which he didn't feel was practical for some of his - as we are writing this daily we will refer to the incidents from hereon as those of the present and not the past - a diary so to speak. At this writing we now have the following:

1. Medicine:
   a. Quinine (Dr. Lyth is afraid Atabrine may cause ill effects unless properly administered.
   b. Eye drops - as the natives always have smoky fires, on the floor, in the middle of their huts, their eyes are always inflamed. Particularly the children have sore eyes. So we may make friends by occasionally treating a person.
   c. Bandages.
   d. Iodine Swabs.
   e. Aspirin (1000 tablets)
   f. Sulfa-Guanadine for dysentery.
   g. Opium Camphorated - for diarrhea

After research we came to the conclusion that the Zee like all natives have many ailments - but the ones we can give them medicine for and treat them for are sore eyes (assuming it is not trachoma), dysentery (both bacillary and amoebic), and help knock out Amoebic Dysentery even though Emetin and Yatrin are the proper medicines.

The WASC have a fairly large hostel built here - but the contemplated Americans never arrived so the buildings are unoccupied.

There is a fairly large airfield here used only by the Chinese Air Force, commanding it is Captain Yu (formerly of Manila) who speaks fairly good American. Assisting him is Lt. Chu, a graduate of the Kunming Air School. The outfit here is a part of the 3rd Route Chinese Air Force.

26 July - We called on Capt. Yu and Lt. Chu in company with Rev. Wright, who acted as interpreter, (much of Yu's American is hard to understand) to solicit his aid in getting proper credentials and help to escort us into the country of the Zee. This is where we made a mistake as we now see it. We should have gone directly to the Magistrate and Gen. Lung. They are the real persons here and playing around with any secondary stuff is a waste of time - however Yu had a story to tell us about the mystery of crew #214 which is:

A few days after the ship crashed a message reached Chaotung about it and Yu immediately sent a Chinese doctor and engineer with food and medicine to bring them to Chaotung. They found the crew and offered them help and food and suggested they return with them - the crew refused, as their report shows, and continued on to I-Pin or Suifu, much to the chagrin and confusion to the Chinese.

When in India briefing the 20th B.C. Major W and Mullen both tried to get the men to understand that Chinese will be picking them up and they can put themselves in their hands - so in this case in view of the fact they were already being guided by a Chinese north and then being approached by some from the south they made a choice which in either event would have turned out O.K.





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We find on checking their map that they were in friendly country almost from the moment they landed and the choice they made was a good one even though it meant many more days of walking.

At this writing Gen. Lung is planning on a review of his troops by a couple of generals from Kunming - so getting an appointment with him for a day or two is going to be tough - we can't proceed until Chen is well - so in the meantime we can catch up on reports and get a much needed theoretical education about the Hes and their country from men here who have been in contact with them - the Chinese here in general do not know much about the Hes - the two have been mortal enemies for centuries and the Chinese are very much afraid of the Hes.

The Hes look upon themselves as a pretty high and mighty race - for centuries they have gone on foraging missions into Chinese localities and have taken many Chinese, as prisoners, to make slaves of them.

There are two types of Hes - the Black and the White. The Black is the rascal - he has enslaved both the Chinese captives and the White Hes who do all the farming and the work in general. However, as the Chinese army finds it necessary they go into the Ne country and with superior weapons do a good job of annihilating and keeping them in hand. (It is the native Chinese and not the army who are afraid of the Lolo or Hes or Nosu or Ne-jiao as he is called.)

27 July - Received an invitation from Gen. Lung to attend the review - these fellows sure know when an American is around. We attended with Mr. Steel - the exercises lasted for about three hours - various maneuvers were demonstrated. Gen Lung and Gen. Liu Yao Yang (the chief of Staff to Gen. Lung Yun the Governor) were very considerate and saw to it that we understand all that was going on.

Mr. Wang, the Magistrate of the First District of Yunnan Province, was there and we made an appointment to see him at 2 p.m. tomorrow.

28 July - we called on Mr. Wang with Capt. Yu, Lt. Chu , and Mr. Lee to obtain a Hu-chao or passport. We told Mr. Wang what our mission was and he said any wars or differences the Yunnan Government may have with the Hes or Lolos as he called them in no way would cause Captain Mullen, as an American Officer, any difficulty.

We made arrangements for 20 coolies, three saddle horses and one sedan chair or Hwa-Gun as the Chinese call it. Chen will have to be carried for a couple of days.

The coolies will cost 300 CN a day per man - don't know the cost of the horses or sedan chair yet.

We want to take salt and more cloth with us - money is not used in the Ne country - coolies are paid in cloth or salt.

The cloth they use is a blue cotton about 18" wide and we are informed by Mr. Lee that you pay them in squares - maybe two squares a day or a piece of cloth 18" x 72" for a days work - salt is paid in ounces.



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In addition to the bolt of cloth we have bought in Kunming for 160000CN we are buying about 600 ft. more which is costing about 21,000CN. (plus the local squeeze)

Salt sold in Chaotung comes from Whangpingtzu (103-30E:27-40N), a town through which we are travelling. Mr. Wang is giving us an official order (which is necessary to buy the amount we need) to enable us to buy 300 lbs or catties - the price is somewhere in the neighborhood of 130 to 150CN a lb.

Mr. Wang informed us we will have to change horses at Whangpingtzu and as well remain there a couple of days until a messenger arrives at the Little Kings to inform him we are coming so we won't be shot. We will have Mr. Lee write him to have coolies at the river to carry our luggage to the palace. The Chinese will not cross the river into the Ee country.

Coolies carry about 60 catties or roughly 70 to 80 lb.

Fruit abounds in this part of the world - to assure one not getting dysentery, soak the fruit for ten minutes in a weak solution of Potassium Permanganate or better yet put a courle of table spoons of the local rice wine in a bowl - light it and drop the fruit in it - stir the fruit around the fire and it will kill the bugs and the fruit can be eaten without the necessity of peeling it.

Received two invitations to attend an opera and a feast tonight and tomorrow night. We no doubt offended Mr. Wang when we refused tomorrow night's invitation. We had already accepted an invitation to eat with the missionaries here - the Chinese customs however is to cancel any invitation which to them is inferior and go to the bigrest party. We had explained that westerners go to the first party whose invitation they accept - Wang could not understand this method. However, as we find the party does not start until seven p.m. we will put in an appearance.

Wang, as a bait, informed us that the opera would only last four hours - if you have never sat through a Chinese opera you can't imagine the misery both mental and physical which can be soaked up in that four hours.

Capt. Yu had called Gen. Lung for a date - but on account of maneuvers he asked to be excused and said Mr. Wang could and would see we were taken care of. Instead of one invitation to the opera two have arrived - one for tonight and one for tomorrow night. As the festivities do not start until seven we have accepted both.

Dr. Lyth accompanied us - we were the guests of Generals Lung and Liu. They were courteous and we enjoyed the evening although we had to Gun-Pei (GOM-BAY) or bottoms up with every branch and rank in the place.

The writer is 6' 1½" and commented on the fact that Lung's army were all pretty tall fellows - Lo! and behold! while the play was going on in marched a gang of Lung's tallest and Mullen had to get up and compare height and beat them all by a few inches which caused much noise and yelling.

Lung is a short fellow and to give him the face and dignity after the measuring act we said: "Size does not make a soldier - look at Napoleon and Gen. U.S. Grant." - as Lung lived in France for six years; he understood our point and he shook hands and we once more had a round of drinks.



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Lung promised to send us a passport which would get us all the army help we needed in getting to the Yangtze River - we have to cross it to get into the country of the Reo.

28 July - We make more arrangements. Received passports from Mr. Wang and had lunch with Capt. Yu, Lt. Chu, Capt. Cahng (Gen. Liu's pilot from Kunming to Chaotung) at the home of Mr. Cheng, the assistant manager of the Bank of China in Chaotung.

As Mr. Wang's guests at the Opera, Liu and Lung appeared to the tune of blazing trumpets and clashing cymbols - the opera goes right on oblivious to all surroundings. The story of one of these events is an unbelieveable one and no one unless they see it would believe any story about it.

True to his word, Gen. Lung brought us a passport assuring us safe guidance to the border of Yunnan. Capt. Yu also brought us a letter written to the Little King as we intimated before it is going to be a difficult task having distressed airmen delivered into Yunnan province - however we'll see what results can be obtained.

29 July - Left at 0930 - 16 coolies, two Mafus or horse guides, two horses and two fellows carrying a Hwa Gun with Chen ensconsed therein.

Had only reached the city gates when one fellow went on strike because his part of the load was too heavy. So we were detained for over an hour while the head of the coolies went into the city and hired another to assist.

Arrived at the Nalaoputzu Ho (Ho means small river) where we were ferried across in a scow to the western bank - arrived in Sa-yu-ho about 1800 - a distance of 40 Li or a little over 13 miles from Cahotung. Three Chinese Li (LEE) make an American mile.

Stayed in a local inn - roosted next to the horses - the coolies all wanted money. This could give them a chance of getting ahead of the game. One has to be careful he doesn't pay them too much on account or they are liable to run away in the night feeling they are ahead of the game.

30 July - Left Sa-yu-ho at 0700 to the tune of the usual arguing and haggling about money.

The Chinese like Christians, philosophize on calmness and serenity and seldom give any credence to the philosophy.

There is no army control here as in other parts but even though in other parts of China the army harrasses the people they do squeeze some sort of order out of this chaos.

As Mullen lost a front tooth by kissing the ground in an unmainly fashion his appearance is somewhat like the coolies - very few of them have front teeth.

1 August - We left the valley of Sa-yu-ho and climbed up from 2300' to 8700' - um - up for hours - we could see for miles - at least 50 in every direction.

We travelled 70 Li or 23 miles today to a town called Heu-Yakow to cross



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the Hsiaputzu Ho - the coolies stripped and as the water was up to their waste they got a slight rising - they are a filthy lot - the odor which eminates from them is foul and if you are down wind you can smell them for 100 yds. as the trail winds you never can really get up wind from all of them.

We established that a plane going 180 miles an hour can fly in 7 to 8 minutes what it took us all day to walk. A crew which bails out, one hour by air from its base, needs a month's time in which to return by foot and horseback.

2 August - Covered 70 Li (Approx 24 miles) today arriving at Yungshan (103-35E:27-50N) over trails which do not show on the map - note - look at the map and you will see no trails leading in or out of the town. It is the largest city in extreme northern Yunnan. Chinese maps are a study of incorrectness. It seems if the makers thought a river would look good on the map or a town looked better spotted one place than another they, for art's sake, put them there.

For example, look at 104-13E:26-38N, there is a river shown with a Ferry crossing. In true Chinese philosophy a river should be there, so they put it on the map - and in figuring in their way, one would arrive at the conclusion - there is no river in the first place, and if there was a river in the first place a ferry would be needed in the second place. However, if there was no ferry in the second place there is no need for a river in the first place.

The country we are now in is such as that written by the Rev Chapman Andrews, the Theodore Roosevelt Jr. and Dr. Rock- however, no diction has yet been developed which would enable the "minds eye" to visualize the magnitude of this country - it goes way beyond stark realism. Dante must have visited here before writing his "Inferno". The elements sure had quite a battle when this part of the world was developed.

We are housed in the Magistrate's conference room. We had a letter to him from Mr. Wang of Chaotung and as is usual the magistrates in various villages furnish rooms.

Our coolies and Mafus leave us here which means we will have to make arrangements for new ones to take us on our way.

As we were near the Ze country we noticed more people carrying guns - our wild west was a sunday school along side the legends about this part of the world. The truth cut in half still would sound like an exaggeration - one can well imagine why no one would believe Marco Polo. To go back a little in the story!

Living in the hills near Chaotung are a tribe of people called the Miao (MZ-YOWS). They are a destitute sorry lot who at one time owned the more fertile valleys. But over a period of centuries have been drawn up into the hills - even they look down on themselves as a no good people. The Methodist found them living like rats and practing sexual relations as rotten as the world has ever seen. They had a high percentage of syphilis and gonorrhea - but it only took a few years to turn them into different channels. They now play basket ball, foot ball, have yearly competitive games with other



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tribes and a few years ago one of them was the validitorian at the commencement exercises at the famed college of Chengtu and received high commendation from Generalissimo and Madame Chiang Kai-shek attending the rites.

This man called on us in Chaotung and thanked America for its help to China and asked if there was anything he could do to help. We accepted his thanks and informed him the way he could help was to keep building up his people so they could be free of disease and want.

The following day he called on us in company with 40 of his students who were in Chaotung on a trip and asked if we would like to hear them sing. The Chinese are the world's worst singers - they sing through their noses and after a session at two operas the full forcefulness of their lack of vocal expressions is adequate - however, these Miaos are just the reverse. They sing four parts in harmony and their throaty rendition of "Lead Kindly Light" was revelation.

The Miaos are in different parts of China and any of our men meeting them will be among friends. Some crew, some of these days is sure going to be quite surprised when they hear Rock of ages or "Onward Christian Soldiers" ringing throughout the hills.

8 August - Mr. Chen is recovering from Malaria, Mr. Lee has a cold and Capt. Mullen an attack of dysentery. So the expedition has slown down to a complete stop for 24 hours. We are getting a much needed rest, new coolies and brushing up on our knowledge of the Ze-wrens and their country. Tomorrow we drop down 70 Li to the valley of the Yangtze River.

Provinces in which we travel have interesting derivations:

(a) Yunnan - in Chinese literally it means "south of the clouds" - the mountains north of it are always in the clouds.

(b) Kweichow - (GWAY-JOE) - meaning Precious district.

(c) Szechwan - (SZE-CH-WAN) - meaning four rivers because there are four rivers flowing in the province.

(d) Sikang - (SEE-KIN) -Kang is a tribe in Szechwan and Si (SIE) means west. Hence Sikang or West of the Kangs.

The Magistrate of Yunnanan Mr. Chang, the village leader of Whangchuchu Mr. Dwan, the Chairman of the People's Political Council of Yungsian Hsien, and various gentry have been here part of the day telling us about our trip. The Chairman, Mr. Ngo Yin Hsien, drew us a map and as one of the King of the Ze is a step-son of his. So he is sending a letter along with us to him. "Step-son" in China is not as we know it. Its a pseudo title such as having a youngster call a friend uncle or aunt. The chairman in fact has many step-sons in the Ze tribes and until it was fully explained what he meant by step-son much exclamation at the fertility and verility of his predecessor was heard.

We needed more money. So we borrowed CN60,000 from the Tax Bureau here and wired Kunming (AGAS) to bank this amount to their account in the Bank of China in Chaotung.



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Observations on the trail:-

1. If China ever learns the art of exploiting it's natural beauty they can attract many tourists.

2. For sheer ruggedness, cussedness and surefootedness our western mustang has it all over these Chinese ponies which originated in Tibet.

3. This would make great sheep and cattle country.

4. There is enough power in these mountain streams to transform this entire country.

5. Would suggest the missionaries teach the natives that "cleanliness is akin to Godliness." With streams only a few feet from the native's doors they wouldn't have to exert much effort to take a bath occasionally.

6. Chinese whiskey, like their cursing, is not very good.

7. Their cooking is very palatable and it is best not to ask how or what a dish is prepared of. The answer often upsets a nervous stomach.

4 August - Travelled over circuitous routes (trails) for 75 Li and down into the gorge of the Yangtze. The overlay will give an idea of the general direction. China is a myriad of trails and no map could show even a slight portion of them.

We travelled along one river for a while which is not on the map. This we christened Mo-Len Ho. The stream is filled with minerals and tastes badly - so to get even with it for not being drinkable they don't show it on the map.

There are many minerals around here - copper mainly - some silver and gold as well.

We arrived and stayed at Mr. Lee's - descendant of 10 generations in the vicinity called Ho-kow. They have boats and are going to ferry us across into the Ze country which is directly across the river from here. We dropped down from 7000 to 8000 feet and tomorrow we have to climb right back up to one place we are going to call at in the Ze country.

An Ze-wren passing through here was detailed by Mr. Lee who knew we were coming (we had sent a runner ahead) to guide us to our first stop.

The fellow we are going to call on is the one mentioned earlier in the story as the one which is supposed to be a renegade and has been aided militarily by Gen Lung in Chentung.

The story here about the treatment of crew #2 is the natives thought they were Japs. They have never seen an American and they thought men were landing from the plane to attack them.



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Our pamphlets which will be distributed somewhere later will help - and the present expedition may be able to accomplish some good. We will try to avert having a repetition of the treatment accorded crew #314.

Observations:-

1. Beautiful and rugged country.
2. The Yangtze has dug quite a gorge here through the centuries.
3. Opium is 2500CN an ounce or at Kunming prices about $13.80 in American money.
4. Missionaries about 30 years ago introduced Irish potatoes in the country and it is becoming one of their main products.
5. No American has ever been here before the arrival today of the creator of this narrative and he is carrying on a one-man side show - the last whites or only ones to be here went through here 30 some years ago - some French and English missionaries collecting stones - they must have been geologists.
6. Never ask a Chinese the distance from one place to another. The answers and results are always disappointing.
7. Any Americans stranded on the east bank of the Yangtze, other than physical difficulties due to the terrain, will be treated well by the people, who are always glad to help their benefactor Americans.

The Lee brothers put on a great feast for us. They killed a sheep, served chicken with it, and rice, and eggs. We got to bed at 11 p.m. which is too late for this country.

5 August - We were not able to cross the river until 11 a.m. It was too high and the boat had to be pulled upstream for a long distance so when crossing it could land somewhere on the other side near the trail. There were so many, of us two trips had to be made.

In our boat were three of us, some natives and 11 goats. It was difficult to determine which was the more odoriferous - the goats or the natives. The opinion was the natives won by a wide margin.

This was one of the toughest days of any we have had in China. From the river we climbed straight up for 6000 ft. One misstep and we would have dropped down into the river. The trail was not more than 24" wide at places - how the coolies got up it is a miracle. On the top was a space about 50 ft. wide, then we started down once more on a trail which is not discernable to the unpracticed eye. We arrived in a narrow valley at the second home of the Lees. Their father lives there because he and Gen Lung don't get along - at his place the opium smokers gather.

This part of the world is additional to the habit which has benumbed the senses of practically all the males - young fellows smoke it as well.

From the Lees we started up a worse trail crossing and recrossing a mountain stream which went roaring down over the rocks into the Yangtze.

Plane after plane passed overhead - as this is being written a B-29 is roaring above us.

We climbed and climbed interminably until 9:30 at night when we reached a small plateau on which lives the first group of Kewrens we are to visit.



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The place, a mud fortress, is located in the side of a hill which rises to the south of the plateau.

We arrived to the tune of a hundred yelling dogs and the light of a full moon enabled us to see where we were going.

We were escorted to a large mud building in which was the greatest conglameration imaginable - women, men, dogs, horses, prisoners, chickens and the usual fire on the floor in the middle of the room.

We were informed the King was asleep - only to be immediately advised he was on the royal diadem smoking the royal opium. He sent for us and we called on him in his small oil lamp lit room. As he was so full of opium we said we were tired and asked him to excuse us until tomorrow when all of us will have clearer heads.

When in the Lee home on this side of the valley an Ewren appeared and said he was sent to escort us to his ruler who is the so called King about whom we mentioned earlier as being a Central Government adherant. On questioning how he knew we were coming he said they had been watching us for hours crossing the river and coming up the trail. We dispatched him to his master with a note that within a few days we would call on him.

The place we are now in is called Nga-ko (NA-KO) and the King's name is AN SHU-DER. He is 28 years old and is a fairly decent and healthy looking fellow and is the 8th generation here. The title stems from the Ming Dynasty about 500 years ago.

6 August - We negotiated with his Highness about helping our men and Enclosure #3 is the agreement we arrived at regarding compensation.

This fellow has two wives - one is the former wife of the deceased ruler who formerly lived at Silo (102-45E:27-40N), see the map. This marriage has given him influence over the section indicated on the map and he says our men will be aided in getting out of the country safely.

If they are in the country around Na-ko they will be escorted to Chaotung; if they are on the other side of the country in the second wife's country they will be sent to Sichang. The King is dispatching directions immediately to the second wife's country. He himself, is soon going to pay her a visit.

We presented him with cloth, medicine, cigarettes, candy, cigarette lighters, and some other odd sundries.

We were so exhausted last night we practically collapsed and it was not until this morning we were informed a pig had been killed in our honor.

This morning a goat was hauled in and a rooster and both killed before us in our honor. They were cooked and we all had a royal feast. About 4 p.m. a group called on us and the leader told us a cow was to be killed in our honor. We asked they not do this - they retaliated by saying that we need not eat any of it - that they would eat it and that all they wanted us to do was to accept the honor. So, we accepted with alacrity and told them we would help them eat it.



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At about midnight in a smoke infested room to the light of smudge oil lamps we had another feast - dogs, cats, smelling cookies, Ee-wrens, horses and general confusion ran rampant - but we made the grade and about 1:30 crawled in full of cow, chicken, and goat.

6 August - Before departing we held clinic - treated sore eyes, bound wounds, treated diarrhea, dysentery, and the great ailment - belly-ache. CC pills were dispensed in profusion and also Bismuth Sub-Carbonate.

We headed on N.W. and late in the day after crawling up and down trails arrived at Wu-chew, another kingdom. No whiteman has ever been in this part of the world before and the writer was like a freak in a side-show.

The people here were pretty sour for quite a while. But between Mr. Lee and James Chen they at last granted us the privilage of sleeping in their meeting place which had the roof blown off.

The King and Her Royal Highness (who could spit as well as anyone we have ever seen) squatted near the fire and after a couple of hours of supar, some candy and cigarettes they warmed up and we had a fairly good time discussing our problems.

We told them it was we who had circled over their home a few weeks previous and then we were really in their good graces.

An old Life Magazine or two we were carrying interested them and when we, with ceremonious efforts, presented His and Her Royal Highness with a "C" Ration tin our acceptance was complete.

His Highness is called TI-GU-SA-SA (TI-GU is the family name: SA-SA is the King's surname). Like most things out here everything is backwards or upside down.

SA-SA killed a goat in our honor and we had boiled blood as an appetizer and kidneys and testicles for dessert. Most food here is boiled and it is tasteless. However, the water is served, as a soup, which helps.

We treated the King and his wife's smoke disturbed eyes. In fact, almost everyone in this part of the world have sore eyes caused from the smoke. Drops were used and at least this crowd will feel good for a few hours.

Horses are few and far between out here - the country is so rugged a horse could not be used if there were any.

7 August - We were up at 4:15 AM and on the trail at five - a short way northwest we stopped at Chu-Hung (JIH-HOOM) to pay our respect to another king, TI-GU-JIA-JIA, who was, as all natives, an inquisitive and annoying lot; but in general was happy and interested in helping us.

We failed to mention that at each place we left our calling cards (Enclosure #4) on which was written a message to distressed airmen and is to be shown them so they will know they are in friendly hands.



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Guards and Escorts were furnished us here and accompanied by the King - TI-GU-JIA-JIA. We headed to the top of the mountains from where were sent on our way. The King informed us that from here on the next tribe were his enemies and he could not go on with us.

In fact, each tribe is hemmed in a valley or section by others all who are enemies and these folks are the real McCoy when it comes to Feuding. Our Kentucky Hill Billies must have taken their postgraduate courses from them.

The crowd in Wu-Chew, TI-KU-SA-SA and his people, will take our men to Yungshan or Chaotung and the Chu-Hung gang will escort them to King An Shu-der's at Na-ko or to the Lee brothers. Even though these birds are enemies of each other, we are sure hostilities will cease long enough to allow Americans to be escorted on their way.

Accompanying us was an old fellow who said he knew someone at our next stop and he would not be afraid to lead us - and lead us he did, in fact we went 70 Li off the trail to pass around some personal enemies of his and it was 10:30 at night (a day of 18 hours on the trail) when we slid down a mountain in a rain storm into Lei-chi. There wasn't a fibre in any of us which was not drawn to the breaking point. We were cut, bleeding and dirty as Hogs, cold and wet through.

We had sent a runner from one of the villages ahead to inform the ruler we were coming. They sent out men, with wood flares, to guide us to the proper place or we might still be up there in the hills.

A goat had been killed - at about midnight we ate it.

There are two meals a day here: one about 11 a.m. and the other about midnight. All the men and most of the women smoke opium and as James Chen put it "We will always remember the beautiful country inhabited by corpses." Nothing in God's world can putrify as a human being.

The ruler Mr. Young Chung-hsien was away but the Queen Mother (a Regal person) was at home and we had quite a visit with her. She informed us the crew we were looking for had landed on the hill overlooking her home and she had gone to the next village, where they were entertained, to invite them to her home.

We asked her what she thought they were when they landed, and she said, "I thought they were "FAIRIES FROM HEAVEN!" so, herein, hereafter crew #314 will be known as the FAIRIES FROM HEAVEN. No doubt the 20th A.C. will covet the honor - but it's a unique if not a manly and courageous christening.

Crew #314 or the FAIRIES FROM HEAVEN are a legend and will be for a long time in this part of the world. The people were afraid of them at first because they had come from the heavens - and coupled with the fact they were thought to be Japs caused no little concern as to whether to shoot them or sell them to the Black Mos for slaves. In fact, the fate of this crew hung in the balance for quite some time and only the grace of the Almighty are they around to tell the tale.

We were informed that the two EM who were sent from Sichang had stayed eight days here and between them and the Chinese soldiers accompanying them plus 60 Ee-wrens had eaten one cow, five goats, two chickens, eight catties



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of rice and twelve boxes of corn flour.

These men have returned to Sichang. They are the first two Americans, in fact no doubt the only, white men to ever be seen in a big part of their journey and their being seen by the natives will be of inestimable value to distressed airmen.

These men volunteered for the trip and their dauntless courage in pushing into a country unknown calls for a real commendation and we are going to recommend them for the "Soldier's Medal".

On interrogation, the Queen informed us that language difficulties, injuries, and the fact some Chinese merchants travelling through the country informed the Ee-wrens the men were Japanese were the cause of THE FAIRIES being detained so long in the country.

Now, however, that have been seen (the people came from miles around to look at them) we need have no fear that any future unfortunates will have any difficulties in the country.

Anyone in difficulty here will be escorted to the King at Miku (MXE-000) which will be our next stop and who is the big King around here and the mortal enemy of King An Shu-der of Na-ko.

8 August - We could see our next stopping place way over on the far mountain. Miku the inland seat of Government of King An-Den-chun who has a brother controlling over the village of Tapintau where the Fairies were entertained for three days. This is the fellow to whom we had dispatched the runner in the second home of the Lee brothers after we crossed the river, telling him we were on our way to call on him.

Poppy fields are scattered around - the opium trade between the Chinese and the Ees is enormous. The Ees and the Chinese may be enemies but trade relation is carried quite extensively.

Our mission is purely a friendly one to aid our own people and nothing other than our mission was ever discussed; other than the usual physical distress, we were treated as best could be expected. Each morning we held clinic and dispensed with considerable medicines and gifts were also given.

These Kingdoms are purely land grants given favorites back in the Ming Dynasty and carried on into the Ching Dynasty. The decendants are many and actually the Kings now are magistrates in the eyes of the present Chinese Central Government and their days are rapidly on the wane.

Mr. Young, the ruler around Leichi is at Miku waiting for us. He has (so it is said) influence with the Black Ees (none of whom we have seen yet); so far, our travels have been in the countries of the White Ees.

Mid-afternoon we arrived at Muku of the section known as Sa-ah where crew #314 actually bailed out and spent their time. King An Den-chun was awaiting our arrival and had killed a goat in our honor and immediately informed us he would entertain us for four days.

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Notice, all these people are of the An family. 300 years have brought about quite a large stock of them - however they are all enemies of each other.

King An Den-chun was at home in Niku and Mr. Young was in a Black Ee's house near the place where the plane crashed. After the accident, Mr. Young went out himself to see what had happened and took care of Lt. Sloan while the other boys were taken to the Royal palace. The facts pertaining to the treatment accorded them are to be accepted - however, details about names, men who entertained them and particulars in general are distorted due to their not knowing with whom they were and the volatile conditions.

King An Den-Chun's story was like the Queen Mother, and as he put it future Americans will have no trouble. In fact they will be welcome from the "heavens and the earth, although they did wish our planes would not destroy "so many trees when they crash".

The true story about their dead is they cremate them on a Pyre of walnut, peach or plum branches. These trees are fruitful and the idea of continued progeny is behind the ceremony.

The King, An Den-chun, has a brother by the name of An-Den-wen or An Liang-chen, lives in Ta-pingtzu. He has been to Chungking paying a visit to Generalissimo Chiang Kai-shek on behalf of his brother. Under the influence of Yu Yao-ren, the Director the Yuan of Examinations (one of the five Yuans in the Chinese National Government) on Association on Border Building Affairs has been established. Being quarter and younger and more learned, the brother, An Den-wen, is appointed in charge of the Szechwan-Sikang-Yunnan Branch of that Association. In fact, he handles all the diplomatic affairs for the King.

We did not discuss reward with the King because of his being so much Pro-Central Government. He says he will see men are guided as quickly as possible to Leipo where we will pass through later. (the crew passed through Leipo too)

It was this smart brother who received us when we arrived as his brother the royal highness was away with Mr. Young to settle a fight between two villages in their districts. They came back on 8 August and, after their arrival we feasted and discussed plans for aiding our men.

We held our usual clinic and treated the King's brother, who had many ailments; infected arm, bad eyes, and rapidly rotting kidneys, plus a cancer on his lip. He is quite an interesting fellow and wanted us to help him start a hospital in Tapingtzu manned wholly and souly by Americans. He is quite a smoker and a considerable part of his time is spent on the opium couch.

This brother informed us the guns which were taken from crew #314 by his people were sent to Sichang by the two EE - although Lt. Sloan, C.O. of the crew took his with him. There are a few guns missing. These are supposed to be in the hands of some Black Ees and through Mr. Young he is trying to recover them.

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We have been concerned about the section (102-35E to 103-27E by 27-35N) and this we discussed with King An Den-chun in Miwu. He informed us that part of the country is ruled by Chee-z-se who lives at Chee-ha-va, some in the section noted and we dispatched to him through the King a letter. (Enclosure #5)

Chee-z-se is under the magistrate of Sichang. He has been to Chungking to see the Generalissimo. Both the King and Mr. Lee think that he will guide our Men to Sichang.

We will advise Gen. Chang to reward this fellow's people for any help they may give us.

We sent him a letter in both Chinese and English that can be shown Americans so they will know they are in safe hands.

To the King, his brother and Mr.Young each we wrote and gave a letter thanking them for aiding crew #714. (See enclosure #4)

10 August - Mr. Young (quite a stupid mess and a great friend of the Black Les) when fully loaded with opium and local whiskey proferred us in an invitation such as only the Gods should have. He invited us to be his guests for ten years, during which time we could eat plenty of his cows, lots of goats, lots of chickens and he could smoke all our cigarettes and in turn he would permit us to drink all his whiskey with him.

It was with long face and sour stomach reluctance we declined and left Miwu accompanied by Mr. Young and headed toward the Black Le country.

When we speak of country it is purely in the sense of different valleys. These tribes are hemmed in a pretty small area figuring it in degrees - but it is of the most rugged in the world.

There are no villages. There is no little flat space that houses are spread out all over the hillsides. There is not any flat places where a village could be built. Each house has a fort attached. These forts are built to protect individual homes from being attacked by the raiders. The houses have mud walls, wooden roofs and dirt floors all living things exist inside the walls of each home. They are pretty dirty - no windows and other than the fire and an oil lamp of pre-biblical vintage, there is no light whatsoever.

We found the Black Les more presentable than the White. The Black are more vicious, more annoying and in general more virile. The untrained eye could not tell the Black from the White. Both groups wear big flowering trousers, almost like skirts, which almost touch the ground. The women wear folds and folds of skirts which often drag on the ground, an Elizabethan style and Turbans. The men also wear turbans. It is quite a juggling act for them to hold them on their heads while having their eyes treated.

We stopped and visited at home after home on our way - the people all hurried to see us - having never seen a white man before. The size of the writer always brought sighs of amazement and often the largest fellow was singled out to stand alongside him to compare height. In all our travels



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we only found two who were almost as tall. One is a leader, who because of physical stature, not mental showed up and the other a slave. The black Ees have many Chinese slaves.

Writers have a labit of romanticising about people such as these frankly they are a pretty stupid, dirty, immoral, opiated mess of humans.

China of the future will either have to annihilate or educate these people. At present, other than furnishing opium to a bunch of no good Chinese the Ees are not contributing very much to the present stature of this nation and it goes against the grain to have to endure such hardships to barter for American lives, anyone of which is worth more than the whole crowd of them.

As the country has not been mapped the villages we called on are not on my maps and where we indicate them to be is mainly guess work. We know the direction in which we travelled, but because of the terrain we do not know the distance covered.

As we had sent a runner ahead the entire crowd around Dry Gulch or Gun G, were waiting to greet us and we were escorted to the village leader's home. Much to our amazement the courtyard was clean and the floor of the house swept. Another indication of the difference between the Black and the White.

Their greatest interest of course as it was all through the country was our firearms, which we as a matter of course prohibited them handling unless we permitted them to.

We told them some Americans had landed in their country and had had their guns taken from them. Even though this dastardly act had been committed we still came as friends to inform them Americans are a very friendly people, a very powerful people and would not stand for such treatment.

They said they had nothing to do with the bad deed and would help Americans in anyway they could.

Despite the verility of these people they are a disease ridden lot. There are signs of syphillis, Leprosy and a lot of diseases we could not diagnose. If and when anyone sends a medical expedition in here they should send an educational unit as well. The elders can't be taught but the kiddies can and in a generation or two they should be a part of the nation. They killed a goat and we had a feast of practically uncooked food. We held the usual clinic, and one fellow, the brother of the village leader who was a pretty bad actor insisted on much medicine and the dosage of 4 C.C. pills we gave him was slight revenge for the annoyance he caused us.

There was one other fellow earlier in the story who we ran into in Miku who had accompanied the two EM from Chaochio and was stricken with malaria (so he said) who was a nuisance and we gave him 3 C.C. pills and we got rid of him.

11 August - We proceeded east heading on back toward the Yangtze calling on homes, letting the people look at the writer and listen to the story told by Mr. Lee and Jimmy and in the main despite the terrain and the usual stomach aches from cold mountain water we did not suffer too much.



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12 August to 13 August - Two more days of walking up only to go down only to go up. At noon of the 12th we arrived at Na-ko-lo, a section overlooking the Yangtze and here we met quite a fellow - King An Hsien Chung - a Black Ee who neither smoked nor drank and his home was large and clean. Both he and his wife are a delightful couple and had we not the intense desire to get across the river to Hwangkwoshu (103-35E:27-50N) to where we had sent some of our things from Yungshan, we would have spent a day or two to get a much needed rest and to spend a few hours in a home that is clean.

Before leaving King An Hsien Chung we wrote a letter which he will deliver to another Black Ee to the north and he says between the two of them they cover quite a large section and if Americans need help he will see they get it and will deliver them to Yungshan.

This big fellow (and he is a healthy one) is noted for his feasts - so it will be good fortune for whomever gets in his hands.

After the Ee country one fully realizes that the Chinese side of the Yangtze has some semblance of unification. There are no towns stores nor anything one can call part of an organized society in the Ee country; whereas the Chinese, despite their lack of sanitation and annoying actions of always following and staring at you are a pretty agreeable and nice people.

14-15 August - Spent two days in Hwangkwoshu in constant confab with the village Home Guard Leader. The village leader, who we had met in Yungshan, had not returned, but had sent a message ahead that we were eventually going to pass through his town and to see we were properly taken care of.

Our coolies left us here and started back to Yungshan and we had to go through the pange of getting and training new ones. As we had to use farmers (not professional coolies) they insisted we cut our loads to a minimum or they would not carry at all. A coolie usually carries 60 to 70 pounds, but the heaviest load of one of this bunch had was 48 lbs.

16 August - Walked 70 Li to Wu-chi (103-30E:28-5N). The village leader on our arrival was on his opium couch, so he could not see us - however, his secretary and a couple of village elders called on us. In view of the fact we had bought a few eggs they got the idea for a present and shortly we had three dozen of them brought in at various times. We slept on the floor of a dirty inn and at 0430 on - 17 August - we started on our way north and east toward the Yangtze. Our coolies refused to hurry and it took us all day to walk about 20 miles - although we were dropping down to the Yangtze valley once more and it was mighty hot. We should have been able to reach Leipo (once more in the Ee country) by dark. Instead we slept in a house on a cliff and at daybreak on - 18 August - we dropped down to the Yangtze and crossed it once more in a flat bottomed scow, and climbed up to Leipo (103-20E: 28-20N) arriving there about noon.

Crew #214 stayed overnight in this town and according to their report were treated very well. The town, even though in Ee country, is Chinese dominated and it is quite a beautiful place nestling in the hills. We were met by the town elders (the Magistrate was away) and escorted to their primary school where we are at this writing.



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Rumors are running rampant - that we are members of Crew #314 who just escaped from the Lee - that we are here to punish the Lee for robbing our men - that we are heading into the Le country to salvage the plane - that 100 airplanes are to fly over here today and so on.

The Magistrate there is attending a meeting in Loshan (103-43E:29-35N) where plans are being made by the Central Government to start a three point drive into the Le country to once and for all clean them out. It is reported that within the last month over 100 Chinese have been captured by the Lee and sold into slavery. This coupled with the fact that our planes are flying over the country is giving the Chinese Central Government much concern and it is the writer's opinion that a concerted effort is under way to do everything within the power of the Central Government to protect our American Flying Personnel.

The Lees' days are about over. However, we don't want to lose our men and we have forcefully brought this point to the fore both with the Lee and the Chinese and our efforts should guarantee our men a fair chance of coming out of the country safely. The Le country is the roughest terrain in the world. Anything we encountered near the Hump in west China is child's play along side of this part of the world. Crew #314 can attest to its ruggedness.

On leaving La-pi-tu, where we stayed last night, Crew #314 was fired on by the Lee across the river and had to remain under cover until nightfall before they could proceed. We did not have a similar experience. Everything was quiet, although we did have to walk an extra 20 Li because the boat was destroyed where we were to have crossed. and to ford the Yangtze we had to crawl up and down the extra distance to another ferry.

Back in Leipo, Mr. Lee made an appointment for us to talk to a couple of pseudo big shot Black Lee who were in that town. When he went to get them they were so drunk that the meeting had to be called off.

Today we visited with the Magistrate's secretary Mr. Chao, and Mr. Du, in-charge of the Kuomingtang Party office here, and some old influentials of the districts and ellicited their aid in getting the Lee around here to bring in our men and to reward them for doing so. This was agreed upon and tomorrow we are going to outline a plan as to how this best can be done.

19 August - Was spent in Leipo. Dysentery has us on the ropes - medication has little effect on it.

Mr. Lee brought a Mr. Wang of Le-Z-Chen, a small village we went through south of here on the Yangtze, Mr. Ma Chao-gun, a Black Le leader of See-ma-chee which is an Le-wren village 4 days march west of here into the Le country, and his cousin to discuss our mission.

Mr. Ma is 6' tall, a pretty good looking 29 year old Black Le who attended school in Chaotung. He will support us and will guide any unfortunates he finds to Leipo. We presented them out of a rapidly diminishing store presents of cigarettes, candy, and tobacco.

This mission like so many more can only be judged by the final results - and only those are the real payoff.



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Rumors are the Chinese Central Government fully intends to lick once and for all their problem of slavery and politics in the Ee country. All this will assure Americans a better chance of survival.

We had intended heading west from here to Sichang via Opien, Mapien, and Yuanhi. But events necessitate our going to Suifu (I-Pin) to work out an agreement with the local bigwigs there. Later a mission should start from Sichang and come east to Leipo. Chances of getting through, more quickly, are better starting from there. Central Government troops can be gotten in Sichang to come to Leipo to guard and see the coolies can be safely returned to their homes.

Everyone we have talked to have informed us that news about a distressed crew would spread like wild fire even in the most inaccesible of places and there is not a chance that a crew landing in Barbarian Ee country could be kept captives or killed without the news reaching the outside world. We asked about explosions in the air etc. hoping someone can give us a clue about other planes but so far we have had nothing other than negative reports. The city elders gave us a dinner and thanked us for coming to Leipo. We in turn expressed our desire to help them and all Chinese chase the Japs from their country.

Americans coming through here will be housed and fed well. There is plenty of food of all sorts and the people are a pretty agreeable lot.

20 August - Left Leipo, travelled north east, spent night in the filthiest place ever seen in our travels. We had a mass of flea, lice and bed bug bites - it was some nightmare. The place, not noted on the map in Ching Kou which is on the edge of the Ee (Black) country. The big shot of the place is a manager of Tung Sen Syndicate, Mr. Fan Yun Hwei (facial characteristics of a Chinese Jew). The Syndicate is an organization set up by some Central Government officials to buy and cultivate lands and raise cattle.

21 August - continued on our way over the same trail used by Crew #314. They had been shot at between Chin Kou and Ma Hu Village. However, we encountered no difficulty with the people. They still continued to follow us in the street, staring at us - many had seen Crew #314 and knew what white men looked like. However, Captain Mullen was the first white to be seen by many of them.

It took us almost four days to reach a village called Chen Yao-tan (Hands on the Hips) where we rented a small flat bottomed river boat and floated down to Pingyichang. There were formerly steamers service between here and I-Pin, but the war stopped it. We chartered a large river boat and two days later we reached I-Pin where the CNAC has a base.

On the way to I-Pin, we stopped at Suikiang of Yunnan over night. The song of the Yangtze River boatmen done at various tempo is one that should be respected. It makes the Volga Boatmen's Song sound amateurish in comparison.

In I-Pin we learned of a plane wrecked at Kunlien (104-20E;28-10N) the crew are dead (ten members). The C.A.F. had sent two of their men to investigate the case. It maybe XX B. C. Plane #356 lost on 26 August.



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Coffins were ordered through the Magistrate at Kunlien in which to bury the men and recommendations have gone to the 20th B. C. that they send someone to investigate.

From I-Pin we have to fly to Dinjan, India and from there to Kunming - thus completing a little over two months of covering the Ee country.

In conclusion:

1. Do not call the people Lolos - call them Ee-wrens.
2. Do not mention you are from Kunming.
3. Fly east from Sichang to the Yangtze before heading north.
4. Do not be afraid to eat their food.
5. Do not be afraid to drink the water from the mountain streams.
6. Do not be afraid of the Ee-wrens.
7. Encourage them to hurry you out of their country - they - however, will have many feasts in your honor.
8. When they start guiding you out follow them even though they are going the long way around - their tribal wars cause them to go great distances at times.
9. When you reach a Chinese city and are turned over to the Magistrate insist he reward the Ee-wrens immediately and you see personally this is done and do not take the Chinese word that such has been done.
10. There are medicines and food at I-Pin, Leigo, Sichang, Likiang, Shiku, Lanping, and Fort Herts.
11. Other than the physical difficulties due to the rugged terrain crews will be guided to safety.
12. Recommend a copy of the New Testament be carried by each man. It is a great revivor of spiritual and physical factors.

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ENCLOSURE # 1

TRANSLATION OF AN ORDER IN LOLO ISSUED BY GENERALISSIMO CHIANG KAI-SHEK'S FIELD HEADQUARTERS AT SICHANG INSTRUCTING THE LOLOS TO BRING TO SICHANG AMERICAN AIRMEN WHO WERE IN DISTRESS IN THE EE COUNTRY.

1. In our resistance against the Japanese we have got plenty of American airplanes to come to China to help us in the fighting. American flyers are our friends.

2. Ten days ago an American airplane force-landed at Men-ho-po of Sama in Chaochiohsien. Flyers in that plane have been taken to stay in the Ee house waiting for rescue. This office has sent some officers and men to receive them and take them back to here. The family leader of that Ee home is hereby instructed to take good care of the men and give them food, and drinks, and escort them to the Magistracy in Chaochiohsien, or the District Director, or directly to the Sichang Field Headquarters. I will reward the natives for that act. But if they are hurt or robbed by the natives I will send airplanes to bomb the country and direct strong forces to punish the natives.

3. The above message was reported to my Headquarters by some patriotic Ee-wrens. They are guiding officers and men from my Headquarters to received the flyers back to safety. People must turn the Americans over to this receiving party and must not hide them. A parcel of food will be dropped to the Americans by airplane. After picking the parcel up, the native must deliver it promptly to the flyers without delay.

CHIANG KAI-SHEK (Chiang's official name)
Director,
National Military Council.

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ENCLOSURE #3

AGREEMENT SIGNED BY KUO AN SHU-DER OF NA-KO ON RESCUING AND ESCORTING AMERICAN DISTRESSED AIRMEN TO SAFETY.

"I, the Supreme Leader, AN SHOO-DER of the YEE people in AN-KO and in DOOPLE-JIA district in Sikang and Szechwan Provinces of the Republic of China, agrees to help all Americans return to safety who are in distress in my country.

As a reward I am to receive, for each American returned to safety, six (6) yards of colored cloth, some wine and two (2) catties of salt.

Chinese National Dollars 300 (three hundred) per day is to be given each member of the escorting party who return the American or Americans to safety."

(Signed)
AN SHU-DER

(Signed)
Frank J. Mullen
Capt., A.C.
US Army.

ENCLOSURE # 4

Calling cards left with the Lolos with instructions to distressed American airmen.

THE PEOPLE WILL
BEFRIEND & GUIDE
YOU TO SAFETY.

FRANK J. MULLEN
Captain, Air Corps
United States Army

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ENCLOSURE #6

LETTER TO AING ONEE-Z-SA AT ONEE-HE-VA, SIKANG PROVINCE, CHINA

7 AUGUST 1944

Aing Onee-z-sa:

American flyers are here in China to help your brave people chase the wicked Japanese from your country.

Some of these men may need help in your country in case their airplane is destroyed.

The American Government and we are sure the Chinese Government will be grateful for any assistance you give Americans in being returned to Sikang and turned over to the Central Government officials through Mr. Lee, the Chairman of the Border Commission for Minyuen District, Sikang Province.

(Signed)
Frank D. Mullen,
Capt., A.C.
U.S. Army.

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*Letter to Lt. Col. James D. Garcia, 8 February 1944

Dear Jim:

This is in the nature of a progress report which I will get off to you periodically until the immenence of the blessed event makes it unnecessary.

We have now been established in our headquarters at Kharagpur for 5 days - Couch, York, Gallagher, Wormwood, Freret, McReynolds and I with the enlisted men. The general divides his time between here and Delhi. Col. Duncan and Horn are in China on a trip and will return shortly. We live in one end of the headquarters building and have offices in the other, This, however, is only a temporary arrangement until we go into some nearby permanent living quarters.

Our first task here was laying out headquarters office space. I am enclosing as Exhibit "A" a floor plan of the second story of the building showing the assignment of space. The building is two stories high and the first floor is given over to A-4, A-1, and the special staff. We came out with more space than anybody else (which is as it should be) - the only disadvantage is that you are a good distance from the General, but this seemed to be no particular handicap at Salina. We gave the plan to General Wolfe on Sunday and got his approval so we are now going ahead as rapidly as possible to get furniture, etc for our space. This is quite a problem but I think we are making good headway. Of course the tentative layout of space within A-2 which I have made on the sketch is subject to any change you wish made - the only room we are going ahead to get fixed up so it can't be changed (except with difficulty) is the War Room. This is the largest room in the building, and has good natural light, being open at both ends. We are going to cover both large side walls with celotex and put in as good lighting as possible. We have also ordered the floor carpeted (with Indian matting), plenty of chairs, and a special 20 ft. conference table - I spent the morning with the local Indian representative at Midnapore trying to get the ball rolling on all furniture and am going to Calcutta tomorrow with the B24 to work on lighting, paint, and several other items. Gallagher is going along and we are going to make arrangements also for furniture for our officers' club which we plan to install in a building near headquarters. (We have 2 B24's and 2 B25's for staff planes.) The enlisted men are getting along well - there has been no threat at all from other quarters trying to proselyte them and I have managed to keep them busy with our work. They jealously guard our supplies which we have unloaded and locked up. The radios are fine - we have connected one and can pick up some good broadcasts.

About the progress of the project as a whole - it's lousy. Gen. Wolfe is at owrk like a buzz saw stirring these people up. The Engineers have fallen down badly on the rear fields - only Karagpur and Chakulia will be ready by April 1st - two tactical groups will be put in each field. Wing Headquarters will be put temporarily also at Karagpur - Wing Headquarters will be in some buildings now located on this field. Within a few months, 58th Wing Hqtrs will be moved to Kaliakunda as soon as that field is ready to operate. Of course, the final arrangement is on tactical group on each of Piardoba, Dudkundi, Kaliakunda, and Chakulia with Kharagpur reserved for Command Hqtrs and the Service groups. It appears now, however, that these other three fields will not be fully ready before next September

* Letters to Col. Garcia in Comd-Bomb-20-HI, 22 Dec. 1943.

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although we may be able to move groups into them by June. So you can see that our operations here are going to be rather hectic. We have nosed into the details of the Engineer's plans since coming down and have tried to improve a number of unsatisfactory situations - for one thing, I discovered that no briefing room was available in the layout. We brought this to Gen. Wolfe's attention and he told Col. York and me to work out a briefing arrangement which we completed with the Engineers today. What we devised was a standard building to be installed on each of the five fields. It will be on the line and will be connected with Base Operations and the tower. There will be a briefing room, made up as a theater, 60' x 75' with seating for 275 people - i.e. for one entire group's combat crews. It will have a stage and three offices for use by S-2, each 20' x 20'. Off one end will be a large coffee and lounge room for combat crews awaiting briefing or interrogation and off this room will be twelve small rooms, each large enough for a table for 15 people, for interrogation. The idea in placing it on the line is (1) to meet the problems connected with two groups operating from each field and (2) to conserve transportation. In other words, when a mission comes up, one entire group will be brought from their area to the briefing room, briefed, will be passed through the connecting base operations building (which will have weather, communications, etc offices) and out onto the taxiways where they will pick up the planes. They will be followed by a second group which will be briefed while the first group is getting off the ground.

* * *

That seem to be about all to report in a business line. On re-reading the above it is apparent that this is a very ignorant typewriter which I am using. I hope you will not mind the varied ways in which it spells. We are all of us holding up very well under the very trying condition of being in India at all. It is really a pretty awful place and one excellent reason for getting people over here before beginning operations is merely to get them personally oriented to living constantly surrounded by the most appalling filth and degradation of the natives. The climate moreover, even now is unhealthy and, we are told that by the time the units get here it will be very hot and uncomfortable. It seems to be almost impossible to avoid diahorrea (Moninghoff came down last night with terrific cramps, vomiting, diahorrea, etc and had to be given morphine to quiet him down - he is better today but still sick) and the malaria hazard in Bengal is the worst in India. I've had a week of diahorrea myself from which I have just recovered. I pass this on, not as a gripe, but just a theater intelligence - with these minor difficulties I'm having the time of my life. Of course, Gallagher and I have sessions most evenings discussing the almost now undreamed of beauty of the life at Salina and the towering advantages of never getting one foot beyond the continental limits of that most wonderful of all lands, the USA - but we have no serious complaints. There are numerous things to take our minds off such contemplation - for instance, the jackals. Nightly, they gather to howl at us and last Saturday night one visited me in my room. (Needless to say, I was roundly hooted for reporting the occurrence until Gen. Wolfe went to his desk and found jackal foot-prints all over it.) Another diversion is a certain bearer's wife and numerous children who daily wait for us at the gate, present long formal written pleas, and weep great floods of tears, wailing like a thousand banshees all the while, because he stole a carton of cigarettes ~~xxxxxxxxxx~~ from Maj. Freret and has been thrown in jail for two years. This latter item has got so acute that we all went down to the police and told them that a great error had been made, that one of us had, unbeknownst to Maj. Freret, given him the carton of cigarettes and that we



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requested that he be released at once. So far we haven't got him out but it will be worth going to the King Emperor if necessary to get this wild woman and her tribe out of our hair. * * *

Letter dated 25 January 1944

* * *

V.

PERSONAL INFORMATION - CHINA THEATER

The following report is based on a two-week stay in the Kunming-Kweilin-Chengkung area of China, during the month of January, plus extended discussions with people who have had experience in other areas and at all seasons.

Due to the fact that China is at present almost completely cut off from the rest of the world there are many little irritations and minor difficulties connected with service in this theater, such as a total lack of toilet paper, or almost any other kind of paper, not to mention the absence of liquor. At the same time there are many compensating factors which help to make service in China bearable.

The country itself is quite colorful and of great scenic interest; much more so than India. And the people, in sharp contrast to those of India, are for the most part friendly, hospitable, good natured, energetic and cooperative.

During the winter months the weather is much like that of the west central U.S. (Kansas-Colorado), with widespread storms and heavy cloud overcast, considerable rain, and temperatures ranging from chilly at Kweilin to cold at Kunming, and quite cold - freezing or lower - at Chungking and Chengtu. The temperatures, however, even at the 6200 ft. level of Kunming, are not appreciably lower than for New Delhi at the same period. Winter underwear is appreciated but is not absolutely essential.

During the summer months the climate is reputed to be almost unbearably hot and humid throughout all south-central China, closely comparable to the climate of the s.central U. S.

Most of China south of the Yangtze river is quite broken and mountainous, with elevations increasing to the southwest as the mountains range up into the Himalayas and the high plateau of Tibet. Although both Chungking and Chengtu are quite low, a few hundred feet above sea level, mountain ranges to the west and southwest reach up to 14 - 15,000 ft. and make flight operations in this area somewhat hazardous. Chengtu is in a broad level valley of the Yangtze river and with the assistance of radio, let downs are reasonably safe. The main rainy season in all this part of China is during the summer months of June - September, but the storms of this period are said to be broken by clear areas most of the time.

Kunming is at 6200 ft. elevation and is surrounded by mountains of 10-12,000 ft. elevation in all directions, but is located in a broad level valley which aids let-downs.

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Kweilin, on the other hand, while only about 350 feet above sea level and situated on an almost level plain, is made quite hazardous for flying by the fact that the entire area is studded with grotesque cone-shaped rocks projecting up from 800 to 1500 ft. above the level of the plain.

All of the towns of this area are colorful and interesting places to visit, at least once, though the usual filth and foul odors prevail. There are limited resources for personal supply needs, such as soap, tooth brushes, and razor blades, but at exorbitant prices. There is very little in the way of souvenirs and the prices are out of all reason. Amusements are extremely limited but there is usually at least one good hotel, club, or restaurant in each town at which it is safe to eat a dinner of Chinese food (with chopsticks). The hotel at Kweilin, the LaKung, or LaiKung, has a good dining room. There are two modern motion picture theaters at Kunming which show recent American talking pictures, in English. As in India it is extremely important in China to eat only hot, well cooked foods and to drink only hot tea or boiled water. The water in China is much less rexliable than in India, being universally contaminated. The vegetables also are much less safe than in India because of the standard practise in all China of using human excrement for fertilizer.

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Due to the run-away inflation in China the money situation is fantastic. A 100 rupee Indian note, officially worth about 30 dollars U.S., exchanges in Kunming at the present time for 40 to 43 dollars U.S. The U.S. dollar exchanges, in turn, for 100 dollars Chinese, or CN, at the present rate in Kunming, or about 70 dollars in Kweilin. However, prices are even more out of proportion than the rate of exchange. A fifth of Scotch, not always obtainable and never really reliable, since diluted or poisoned whiskey is smuggled in from the Jap occupied areas, sells for 75 to 250 dollars U.S. (25,000 dollars Chinese). In Chinese money one tangerine sells for 10 dollars, an embroidered handkerchief of mediocre quality 80 dollars, a small sil scarf 350 dollars, a fur coat 14,000 dollars, etc. An average meal in Kunming, for example, will cost: Soup 40 dollars, steak 150 dollars, ice cream 50 dollars, and coffee 40 dollars. It will be obvious that an ordinary dinner costs, American money, about two dollars and eighty cents; and it is equally obvious that China is not the place to stock up on gifts and sourvenirs to send back home.

Due to the most rigid gasoline restrictions, and the almost total lack of decent roads, travel in China is very difficult. There is almost no organized transportation system. Official use of Jeeps is extremely limited and as a consequence even official business around an airport or headquarters area is conducted largely on foot. Both at Kunming and Kweilin there is a G. I. bus, which makes two trips to town each evening at Kunming, but only one trip each evening at Kweilin, taking officers twice a week and enlisted men four nights a week. But at both places the bus is so crowded that it is often impossible to find even standing room. There is no G.I. transportation of any kind to the town of Chengkung from the field. This situation is an important factor in maintaining morale and requires additional effort to provide entertainment at the fields. At all fields where we visited there were reasonable good G.I. movies at least every other night.

Uniform requirements are conventional, wool in winter and cottons in summer. Field jackets or British type bush jackets are okay anywhere, including downtown.





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It is not permissable to carry small arms or side arms to any of the towns in the China theater. At the same time it is extremely important to provide for safe storage of small arms since they are at a premium in China and thievery is a very serious problem.

Liquor, other than foul Chinese rice wine, is almost unobtainable. There is no provision for a ration of beer or whiskey (or gin) such as is provided in India. As mentioned earlier, the purchase of either Scotch or Bourbon locally is both expensive and dangerous as an official warning has been posted throughout the theater that the Japs have distributed a stock of liquor in properly sealed and labelled bottles which is diluted and in some cases actually poisoned.

Food and lodging throughout the China theater are provided by the West Asia Service Corps (W.A.S.C.) without charge other than the full amount of the ration allowance ($21.00 per month). Both food and lodging are about on a par with transient accomodations in India, with notable exceptions, such as an almost complete absence of butter, use of Chinese type comforters in place of G.I. blankets, very slow laundry service, etc. One big advantage is that, due to the scarcity of transportation, housing is not so greatly dispersed at in India, with living quarters much more convenient to the mess and working buildings. Also, although the water in China is foul and bad smelling and cannot even be used for tooth brushing unless boiled, there is provision for hot water everywhere for shaving.

Personal equipment items for this theater should be the same as on the list previously supplied for India, with a few exceptions. At least two sets of winter underwear should be taken to China.

Limited supplied of soap, shaving cream, toothpaste, etc. are available on an intermittent basis through the P-X. Clothing needs, with reservations as to size and quantities, can also be supplied on an intermittent basis through the local QM sales stores. A ration of cigarettes is available through the P-X at the rate of a pack a day, or one carton every ten days.

As mentioned earlier, G.I. blankets or mattresses are not available, a cheap Chinese cotton ticking and pad being substituted. Therefore it is very important to bring an air mattress if possible. These are reported to be available through Air Corps supply back in the U.S. If so bring them along by all means (and bring along two extra for us if you can).

All such items as the following should be brought along in sufficient quantities for a six months stay:

Pens, inks, pencils, cigarette lighter fluid, flints, wicks, safety matches, flashlight batteries and bulbs, soap, tooth brushes, tooth powder, shaving cream, razor blades, face lotions, medical supplies or prescription medicines, etc.

Other suggested items are:
Good personal notebook (pocket type), and supply of filler paper. Small personal radio set, preferable battery operated. Belt hook or belt holder for knife, Boy Scout or hunting type. Small gas lantern will be helpful anywhere in China.

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VI. ESCAPE AND EVASION

Excape and evasion work through the CBI theater impresses us as spotty and generally poor, especially as to what is being done from and under the direction of Washington to date, through MISX, OSS, etc. Local escape and evasion work in the China sector is reasonably good - quite good on the point of evasion. Of course escape is an impossible proposition, but it seems that much too little effort has been given to this problem.

It is particularly unfortunate that escape and evasion effort has not been greater in this theater in view of the known difficulties concerning evasion or escape in operating against the Japs and over Jap held areas. As indicated above, the one bright spot in the whole picture is the high percentage of successful evasions by combat crew members forced down in Jap held areas of China; something like 80 to 90 percent we were told.

Our earlier talks with Major Willcox, MISX officer for the India-Burma sector, have now been supplemented by discussions in China with Major Wichtrich, MISX officer for the China sector, and with Col. Williams, 14th A.F. A-2, his assistant, Major Smith, and with Major Davis, S-2 of the 308th Bomb. Group. Major Davis was especially helpful and we believe he will be of further help.

Upon our return to New Delhi a further discussion was held with Col. Willcox at which we were able to make considerable progress in arranging for escape kits and aids, and for courses in escape and evasion for our A-2 and S-2 personnel, and for detailed briefing of our combat crews both in India and China.

Especially in this theater it is wise to discuss Escape and Evasion as two entirely separate items. The following observations apply to Escape:

Actual escapes by prisoners of war from any Japanese camp are considered, for all practical purposes, impossible. This is obviously especially true of Japan proper. In addition to the cruel treatment, close supervision, and the obvious difficulty of a white man making his way unaided among a country of Orientals, there is the further report that prisoners are arbitrarily divided into groups of ten with the understanding that if any one of the ten escapes the remaining nine prisoners are immediately shot.

Some work is now being done to set up communications with P.O.W. through establishment of a new code, which should soon be operatinge. Any detailed briefing on this point will have to await further developments.

A discouraging point is that Major Wichtrich, MISX officer for China, has been given no directive from Washington for work in the areas of Manchuria, Korea, Formosa and Japan. There is an obvious need for a great effort to be made at once in this direction. This should cover such points as Navy liaison, establishing contacts with friendly Chinese shipping and fisherman along the unoccupied coast of China, etc.

A very important point which needs clarification is P.O.W. behavior in connection with Jap interrogation. The official instruction is still



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to follow the Geneva Convention code, despite the fact that the Japs do not recognize it, and to give only name, rank, and serial number. Yet there are so many cases of brutal (and fatal) treatment of prisoners that some people, including both Major Willcox and Maj. Wichtrich believe the Geneva procedure should be revised with respect to interrogation by the Japs. They believe our men should cooperate with Jap interrogators and that an "intelligent" job of talking by our men may give them a better chance for their lives without disclosing too much vital military information.

Other officers with long experience among the Japanese feel that we should hold closely to the Geneva code but give our men special briefing concerning their bearing before Jap officers. They think that our best chance is to show courage and dignity together with respect and good nature, and above all that we should hold our temper under all circumstances. As a last resort it has been suggested that our men might offer to talk if taken before a commanding officer or higher authority. The reason for this is that the lower officers are usually the more brutal, the higher officers more likely to follow the Bushido code of respect for a courageous enemy. To maintain a sullen silence or to display temper is said to infuriate most Japs in any case.

Under no circumstances is it considered wise to deliberately invent stories to feed Jap interrogators. Such schemes are believed to be dynamite (though officially encouraged to some extent by the British in this theater) because the Japs are especially infuriated if they discover or suspect that they have been tricked or fooled. This whole matter seems to require clarification through Washington and is certainly of the utmost importance to us. For male reasons we should have a straight story to give our men. We will continue our investigations along such lines in this area.

EVASION:

The evasion record in China is excellent, almost phenomenal. It is reported by the 14th A.F. that 80 to 90 per cent of their crew members who survive landing in Jap hled areas of China are returned safely to our lines. Some fantastic rescues of U.S. combat crew members have been made from under the very noses of Jap troops in occupied China. In one case a plane was forced down within amile and a half of a Jap air field in the Canton area, yet the five surviving crew members have all been returned safely to our lines, largely through the help of Chinese guerrillas and the native population. A Major factor is also the very careful and detailed briefing of all crew members in advance of each mission on every mile of the route, friendly and enemy villages and areas, etc. Also, all crew members are equipped with practical evasion aids, such as the Pointee-Talkee booklets which make it possible for them to communicate readily with the Chinese.

Brutal treatment of prisoners by the Japanese should be stressed to our men as an added incentive for them to evade capture at all or any cost or effort. There is undoubtedly a high percentage of torture and killings of prisoners taken. The knowledge of this fact should increase the determination of our men to evade capture.



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Appendix "G" to Letter to Lt. Col. Garcia dated 5 Jan 1944

PERSONAL EQUIPMENT & LIVING CONDITIONS
New Delhi - Calcutta areas of India.

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INTRODUCTION -

The following information is presented primarily for casual officers coming to the theater in advance of their units. Much of the information, however, and especially the equipment list, should be of value to all officers. All officers travelling by ATC are advised to obtain pertinent ATC travel booklets at the earliest possible time, particularly the one entitled "Pilgram's Progress", which gives a detailed guide to packing for the trip.

MENTAL ATTITUDE EN ROUTE

The trip and the first experiences in this theater will probably not be especially upsetting for those officers who have travelled extensively or lived abroad, especially in the Orient.

For the sake of others a few comments are in order.

The dangers and discomforts of the trip by air are certainly less than by boat. Nevertheless they are wearing, both physically and mentally, and each individual officer will do well to keep alert, keep his mind on the business ahead or otherwise well occupied, and keep himsel physically fit.

Flying straight through there is a tendency to lose track of the day of the week, of the date, and of directions. This is confusing and a conscious effort should be made to keep track of these two fundamental items. Also, sleep is at a minimum; meals vary widely as to time and type, so that an effort must be made to keep physically well, keep well fed without overeating, keep bowels open, drink plenty of water, sleep at every opportunity.

Conditions in the Indian theater are in many respects quite shocking and most distracting. A conscious effort should be made to keep your thoughts on the job ahead rather than on the filth, disease and degradation that will be found everywhere.

It is impossible to exaggerate the utter filth and vile stench of Indian towns and cities such as Karachi and Calcutta. New Delni is rdatively cleaner, but the people are dirty everywhere. The sight of women and children scooping up warm, fresh cow dung and patting it into little cakes is only a sample of the sights that will shock the more sensitive souls. Lepers or terrible cases of elephantiasis may be encountered at any turn, child beggars, naked, legless, or blind. A universal sullen, cringing attitude by the people who, at the same time, lose no opportunity to cheat, beg, or overcharge, is most irritating. At night, for those quartered in tents or hutments, it will frequently seem that a convention of jackals is being staged just outside the tent flap. One must prepare himself to keep his





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mind on his job rather than on conditions in India. The people here have lived like this for many thousands of years and we are not here to change them, but to help fight a war.

HEALTH PRECAUTIONS

Certain minimum health precautions should be observed en route and in the Theater. Travel is wearing at best under any circumstances, and conditions in India will prove strange and difficult in many respects. Hot water is quite rare. In some places, as at Karachi, water (cold) is only available for short periods three times a day. Beds, when available, are a peculiar Indian style about three degrees less comfortable than an army cot. Toilet facilities frequently consist of a pot under the bed, or in a little closet connecting with the sleeping quarters. Indian "bearers" swarm everywhere, sweeping floors with "feather dusters" watering the yard with goatskin bag water tanks, emptying the pots from under the beds, misplacing your clothing and equipment. (Watch your money, valuables, and guns like a hawk at all times).

The following minimum health precautions are advised:

a. Get plenty of sleep. It is better to be a bit lazy, especially at first, than to be in the hospital doing nobody any good.
b. Eat carefully, regularaly, sparingly. Eat only in army messes, or approved eating places such as Officer's Clubs. Drink water only in such places. Eat no native food. Keep your bowels open. (They will probably be wide open with "Delhi Belly" or the Karachi Krouch", in which case report to infirmary.) Fresh fruits and vegetables are surprisingly abundant and are okay when eaten in an Army mess.
c. Take minimum mosquito precautions. Sleep under a mosquito net at all seasons and in all locations. Don't believe the native bearers who will assure you that the mosquitos are all"finished" dead. Mosquitos and flies carry a variety of strange, and in some cases incurable, diseases. Sleep under a net and if exposed during the hours of darkness use the mosquito repellant which is supplied. It may not work. Some mosquitos seem to love it, but use it anyway.
d. Keep away from natives and native quarters as much as possible, especially at first when you may be upset or have low physical vitality. The air is swarming with virulent germs just waiting to bite your, so stay away from crowds and dusty streets as much as possible. Keep as clean as possible. Bathe frequently.
e. At the flightest sign of temperature, chills, or any noticeable indisposition report at once to the dispensary. It is better to be over-cautious at first so baby yourself a bit.

FINANCIAL

Unless you plan to make large-scale purchases of local souvenirs (which is not adviseable), it is not necessary to come to the theater with much money. Living costs run much the same as in the United States, but there is little else to spend money on. Everyone is advised against investing too heavily in star saphires, carved ivory, etc., as it is customary to be overcharged at least double what the purchase is worth.





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Married officers should allot all but about $100 per mo. as that will be sufficient for ordinary living expenses. Single officers should allot their pay above one hundred dollars to themselves at their U.S. bank.

It is easy to send money home, if it shoudl accumulate, through the Finance Office or by Postal Money Order. (Or you can always get in a crap game).

Officers here ahead of their units will probably be on theater per diem, which is three dollars per day in India. This is in addition to the quarters provided in transient camps or hotels. Obviously such officers will have about ninety dollars per month for food and living expenses.

Food will average about five rupees per day. That is about a dollar and a half. The arrangement where officers are quartered in hotels is European plan, five rupees per day, eat it or not. Where staying in transient camps or travelling, the mess is usually one to two rupees per meal and quarters one to two rupees per night. The total will rarely run over eight rupees per day or about two dollars and forty cents, which is less than the ninety dollars per month expense money.

Laundry will run about the same as in the U.S. but cleaning is more expensive and generally unsatisfactory, resulting in blouses ruined through shrinking. Cleaning will vary from one and a half to four rupees per shirt or trousers, and from three to eight rupees for a blouse. The rupee is worth about thirty cents so it may cost - in Calcutta - up to two dollars and forty cent for dry cleaning a blouse.

Indian "bearers" are paid a rupee to a rupee and a half per day, which means around ten to fifteen dollars a month. They usually serve four to six officers so, what with cut on laundry and cleaning, they do quite well.

Summing up the financial problem it is probably not wise to bring more than one hundred dollars with you unless you plan unusual purchases or expect to serve under unusual conditions. This hundred dollars should be in the form of American Express Co travellers cheques in denominations of ten dollars each. Each officer should leave the country with not over fifty dollars in small bills, in addition to the travellers cheques. This pocket money will serve his needs en route.

LIVING CONDITIONS

Many phases of everyday living are novel in the India theater. The beds are a peculiar Indian affair of woven strips of cloth over a rickety wood frame. The waste plumbing, where there is any, is of the open-air type, concrete troughs, even in hotels. Barber shops are mostly non-existent, the practice being for a barber to come to your room and give you a mediocre haircut. There are a few barber shops of a sort; one adjacent to the Taj "hotel" at New Delhi, and one in Calcutta at the Whiteaway, Laidlaw & Co. Dept. store.

Laundries are known as dobbies, or dhobies, and are chiefly notable for transmitting the dhobi itch to a large percentage of newcomers. This is a serious inconvenience, almost identical with poison oak or poison ivy and affects the same people as are allergic to poison oak. It is caused

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by the laundry mark which the dhobies put on the clothes with the juice of a poisonous native nut. Guard against this at all costs by demanding that no dhobie mark be put on your clothes. If one is ( it is usually a single black dot, or two or three dots to-gether ) place adhesive tape over the mark. Do not permit it to contact your skin.

The dobbies are all alike. They wash the clothes in cold water, without soap, by dipping them in the water and then beating them against a rock. This doesn't get the clothes clean but it soon wears them out so that you are forced to buy clean new clothes.

Cleaning, as mentioned earlier, is almost impossible. It is expensive and untrustworthy, when it can be had at all. Any organization coming over as a unit should take the trouble to work up its own G.I. cleaning establishment, operated by an enlisted man with experience in the dry cleaning business.

Electricity is varied, when provided. Frequently you will be in quarters where the light is provided by a candle, a lantern, or your flashlight. If there is a supply of electric current it is of one of three kinds. If you are fortunate your electricity will be provided by an American diesel generator supplying 110 volt 60 cycle AC current. If the supply is British, which it usually is, the current will be either AC or DC and of 220 volts. It is not possible to generalize about the English current because even in the same building some offices will have AC and some DC. This makes the problem of electrical appliances and equipment difficult. Electric razors may be used widely if they have a convertor on them for use of the 220 volt DC current. Radios, electric irons, hot plates, fans, etc., all are useful under the same proviso. A unit coming here without its own power should bring along, at all costs, a DC to AC convertor unit.

Shopping for personal needs, covered in more detail below, is not difficult. The PXs are very poorly stocked and such things as toothpaste, not to mention cigarettes, candy, and liquor, are unobtainable, except for a limited rationing system as listed elsewhere. However, the stores of New Delhi and Calcutta are fairly well stocked with personal equipment, notions, etc., which varies from week to week, but is usually adequate though always high priced. The QM sales store, however, is ordinarily well stocked with things like underwear, socks, handkerchiefs, towels, shoes, etc., and of course at G.I. prices.

Transportation is not a very serious problem. Official transportation is provided in the form of hourly shuttle trucks or cars between most of the various army offices and headquarters, S.O.S., Rear Echelon Hq., etc. For special work it is usually possible for an officer on legitimate business to get a jeep or staff car. For personal transportation there are numerous "tongas" in New Delhi and regular taxis or rickshaws in Calcutta. The tonga rate is 15 annas ( the anna is worth 2 cents ) for the first hour and 9 annas for each additional.hour. The rickshaw rate is a bit variable but will run about four annas for a short trip of six or eight blocks. Taxi fares are about the same as in the U.S.

PERSONAL EQUIPMENT



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The personal equipment list given below is based on personal experience and inquiries during the winter season in the Karachi, Calcutta, New Delhi areas. Only heresay evidence is available as to conditions in other areas and at other times of the year. However, it is believed wise to emphasize that the items of equipment listed, other than optional, are essential and should be obtained at any cost before leaving the United States. Optional equipment items are not figured to any weight allowance but are simply given as a check list for the consideration of the individual officer.

Stories and testimony of various people as to weather conditions in the areas covered vary widely. It is our impression that the winter climate in the Karachi, New Delhi, Calcutta areas is very nearly ideal from early November until late February, a period of almost four months. There is usually no rain at all during this time and the days are warm enough to wear cottons, with cool nights that require wearing a top coat and sleeping under blankets.

The hot weather starts late in February and continues unbroken day and night ( so we are assured ) until November. The monsoon rains come in June and continue through September, without materially relieving the heat. The weather in the wet season is wettest in the east, around Calcutta. How hot it gets during the hot season seems to depend on the individual, but it is no doubt most trying at best, and a severe strain on personal health. All clothing has a tendency to mildew and leather to rot during this season.

As a generalization, officers reporting for duty in the Calcutta area are more likely to arrive over-equipped than otherwise. Most items of personal equipment, such as towels, soap, razor blades, etc., can be purchased locally, through the QM sales store or commercially, or can be drawn in the case of issue equipment.

Shopping in Calcutta is a little more difficult than in New Delhi, as the stores at the latter town are all concentrated around a circular town "square". However, there is a wider diversity of better, larger, and better stocked stores in Calcutta. Most of the European or English type stores in Calcutta are located in an area stretching for about half a mile from the vicinity of the Great Eastern Hotel, on Old Court House Street, to the Grand Hotel on Chowringee Road. Prices are generally in line with U.S. prices, but on the high side, ranging from 10 to 100 per cent above what we are accustomed to paying. Flashlights, for example, cost 14 to 18 rupees, or about four to five dollars. A good, swanky military cap at Hanken's, with embroidered ornament, costs 45 rupees or about thirteen dollars and a half. A pair of shndmade shoes of good quality costs about 50 rupees or about fifteen dollars. Leather good s are still plentiful but leather is growing hard to get and prices may be boosted shortly.

The following shopping guide will be of assistance:

IN NEW DELHI:

Many European type shops are located around the circle within easy walking distance of AAF Hq. Prices are generally marked and not subject to bargaining as when buying from native merchants. (Never pay a native shop-keeper's asking price.)



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*History of the 413th Signal Company Aviation

The 413th Signal Company Aviation, with one hundred and seventy four enlisted men and five officer, drifted into the Port of Bombay at Ballard Pier, at 0930 on the 31st of March, 1944, after a tiresome and tedious thirty seven days on the U.S.N.T. Mount Vernon, unwelcomed by the far-from-pleasant odors which reached our nostrils and amazed at the conglamoration of filth, poorly kept buildings, crowded wharfs, beggars by the droves, and a humidity which was already becoming unbearable. The first turbans we saw weren't as picturesque as we had imagined - the Indian's dress appeared dirty, old and ragged. In one body we knew we wouldn't like India, yet, in one body we all left the ship for that first six hour pass in the city of Bombay on the first of April. In the meantime, we were relieved of our fatiguing and frictional duties as ship guards; our tour of duty, thirty seven solid days and nights, was finally completed. We were decidedly relieved to be able to touch mother earth again, and to stretch out our legs - be it on the lands of India or not.

It is almost apparrent that few men enjoyed their pass in Bombay. There had been 100 many strange things - too many strange looking folk. The diseased gave us a feeling of uncleanliness; the beggars kept us wondering whether we should be sorry and give them something, or walk on and say, "Thank God for the United States of America." Our first meals in Bombay were 'snatches' for the most part, bananas being the most popular edible and bad ice cream coming in a close second. Many of the men ended their brief stay at the Red Cross canteen near the ship, sitting there talking about who got gypped the most and by how much, and "How the Hell are we ever going to get used to this rupee, Anna business?" Nearly the entire company was back on board long before the passes were concluded. This was, although having been a miserable environment for 37 days, the nearest to our homeland that we could now reach.

On the second day, we debarked - filled duffle bags and all our belongings, minus a number of losses from 'slickers' on the ship, and an immense appetite for "Let's got there, wherever it is, so that we can take it easy for a few day." Those Indian trains were as amusing as a slapstick comedy and helped us forget the realization that we had to sleep on the hard boards, tiered four high. After the Red Cross had lined up beside us to cater their cookies and cold drinks to an already famished aggregation, we were off - not in a trail of dust, however, but idling mile after mile beside beggars along the tracks, the amounts seemingly increasing as we progressed. Never have we seen so many youngsters (some of them could barely walk for their age and physical build, yet a cigarette was welcomed in an undescribable manner).

Our train had no schedule - it just ran on until someone up in a poorly devised control tower ahead informed us that a "regular" was due any minute from 'suck 'n such' a city. Those so-called 'regulars' really did arrive any minute, as we had been told, but the minute in question was any one of the many which accumulate to make up twenty-four hours. In our G.I. book of India we leaned that time was an unimprotant element in this strange land, and that if an Indian said he would meet us a five o'clock one evening, it meant anywhere from five until midnight - now we knew what the book meant; it wasn't merely picturesque speech.

*History of the 413th Signal Company Aviation, dated 31 March 1944, Twentieth Air Force.

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It wasn't bad enough that we had to sleep with our clothes on, plus tightly fitting leggings, but the mess set-up was exceedingly poor. We wasted many precious hours waiting in line at dirty, crowded railway stations for poor meals. Cleaning facilities for our mess gear were even worse - but we lived, and our company suffered surprisingly little disentary and other ill effects. Our malaria control discipline was excellent - no one would think of forgetting his repellant at sundown, nor would we allow windows to be opened, while freon bombs were used 'by the numbers'.

We arrived at a particularly large city (Nahiti) on the sixth, and were left standing in the station nearly all day, while our amusement was pitched high at the odd-acting natives. Not only were we amused when we probably shouldn't have been, but our sympathies were aroused when victims of venereal diseases and lepers approached the cars for gifts. One of the most "entertaining" spots of the program presented by the Indians at this station was a hair-pulling, kicking, slapping fight between Gypsies - the female of the species - loud in their brilliant (yet soiled) attire. Had any of us seen a couple of sisters in stateside fight as these girls did, we would have made it our duty to do something about it, but here it was amusing and brought cheers from the GI's as one 'pugilist' overdid the other in an especially sound whack on the posterior or had managed to pull out an exceedingly large handful of black, stringy and greasy looking hair by the roots. Previously someone had mentioned "This must be the country God forgot" - and now that statement was increasingly becoming a reality. Anything hitherto could happen, and happen it did!

Finally we departed from this station and in about an hour we had reached a most dismal looking and bleak outpost. Our thoughts need hardly be described, for we though that this was to be our home from now on. However, we were taken by surprise. The 413th wasn't to remain here, but was to continue on - to where, no one knew! Everyone save our personnel left the train, while we kidded the unluckies from the windows and brought on a supply of ration which seemed to be sufficient to last for at least a couple of weeks. Speculation naturally rose to a new ebb as we departed from the outpost, and unmindful of actualities, we pictured ourselves in China, Burma, or Assam - and eventually Tokyo itself!

With the commanding officer of our organization as the train commander (and we had many more cars than we occupied), we again returned to the station where we had spent the whole day in. Tragedy faced us immediately upon rolling into the yard - our locomotive had run over an Indian. One leg was completely decapitated, yet he was living there beneath the wheels. Our boys were not allowed near the scene, and we posted a guard to keep them away, even though most of the men were unaware of what had happened. In the States an incident of this nature would have brought every Tom, Dick and Harry to the scene in curiosity, but in India the passerby takes a glance and continues on his way.

This same railway station was our lodging for the night, and it was here that we first noticed countless numbers of Indians sleeping on every box available, on the pavement, in corners and in every vacant nook and corner around - for many of them evidently have no homes. Among these wanderers were many children, some as young as four and five years of age.



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Without a medical detachment and even without a clear knowledge of where we were going, we departed the following morning. As serious as the situation might have been, nevertheless we were almost enjoying ourselves, being amused at the antics (and natural habits) of the Indians along the way, and seeing the sights never before realized. On Good Friday we were stopped at a siding 'somewhere in India' for a long time, and it was that spot where we all partook of wine which had suddenly appeared from nowhere amongst the rations. With the wine we all turned domestic, and although water was at a premium, many men managed to save enough for shaving, cleaning underclothes and sponge-bathing, using the G.I. helmet to another untold advantage.

On the eighth we were abruptly awakened at about 0400 - evidently we were where we were supposed to be. In double time, practically, we had unloaded ourselves and most of our equipment and were packed into G.I. trucks, driven through the streets of what we leaned later was Khargpur, and were soon in the midst of a rising sun and our camp. Breakfast wasn't human, what with hot cakes, syrup, sausages, hot coffee, it was just too good to be true. We all though this might not be such a bad 'deal' after all. One more ride in trucks after breakfast hurried us to the Signal Area of Hijli, and were 'handed the keys' to twenty-two buildings, plus a lake - our home for God only knew how long.

On the following day, Easter Sunday, we introduced ourselves to the (Compound", Headquarters, XX Bomber Command, to personnel from stateside who had beaten us over, and to the neighboring British troops. Some of us attended Chapel but more of us set to answering letters which had cropped up on us in Bombay - all of us shared the limited supply of fresh water in an attempt to finally clean ourselves up.

On the tenth the 413th officially began operating, or constructing for operations, for the headquarters of the XX Bomber Command - and, with suspicion of malaria surrounding the state of affairs, our first man entered the hospital (dysentary then proved more 'popular' than the dreaded malaria as the patient's record reached our headquarters).

As we were further acquainting ourselves with mosquito netting, limited water and long treks to the Headquarters Squadron mess hall, we were also commencing a gigantic task in the communications section at the compound - and, too, learning as an oddity, that the compound was formerly a prison and once housed the seemingly most popular figure in India, Mahatmas Ghandi.*

Our first inspection by the Commanding General came on the 20th of April, and was 'pretty successful'. Personnel was rather provoked at the thought of having to hold inspections when in overseas posts, but we gradually learned that such would be evident and needed in this zone of foreign duty.

Our own mess hall was under construction when we arrived, and we immediately set to work hurrying it up, meanwhile messing with headquarters squadron. Our first meals in our own mess hall were eaten 'from a squatting

*Editorial comment by R.S. [? Reed Sass, Historical Officer, XX Bomber Command] "False data".



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position', men positioning themselves on the floor, on the scarce benches and on boxes which could be found here and there. We had no tables nor chairs, and the cooks had to prepare food on concrete with holes cut in the flat top, using charcoal as fuel. Our field ranges were inadequate for all-cooking purposes. Eventually, however, the cooks constructed shelves, pastry racks and other cooking aids in order to turn out a better meal. About five months after our arrival, the charcoal stoves were discontinued as we had finally acquired an additional field range and a number of extra pots and pans from Quartermaster. Up until the same time, fresh meat was unobtainable - we ate rations and much spam. Even at this period our ration menu differs greatly from that which is prevalent in the calcutta area.

Up until just recently fresh eggs have been only a dream, but now we are provided a just amount, aiding the morale and the stomach situation of the men in the outfit. Repetition of meals was exceedingly prevalent up until now, and even yet we are very limited in diversifying our orders. Eggs and French toast are served for breakfast at least three times each a week, while Vienna sausages, spam, corned beef and salmon is a 'must'.

We have no steam table and therefore mess personnel has had quite a time attempting to keep food warm on the serving counter. Progress is now being made on the much-needed table, from salvaged parts obtained at the air strip. Steam tables are badly needed in order to keep food inviting to the men, as this type of company works on odd shifts and the time allotment for serving of meals covers at least two hours for each meal.

The dining room itself is fastly taking on a homey appearance, with renovated floor, artificial ceiling, new paint, masonite table tops, ash trays, etc.

Another difficulty run into was keeping food from spoiling and the ice situation. At first the men were drinking water at about 90 degrees temperature - and had to like it. All the ice we were able to get at first, which was very little, was obtained from Calcutta. Added to this discontent was the all important fact that our groceries could not be kept because of lack of cooling system. A great amount spoiled continuously.

The ice situation has recently changed with the construction and commencement of operations of the new ice plant at Salue - our meats and other perishables now are kept well, and the men always are provided with refreshing cold drinks at every meal. * * *

During the summer months one of our drivers collided with an Indian civilian riding a motorcycle. The enlisted man was road-testing a quarter-ton, four by four Ford at the time. The civilian ran in front of him from a side road without giving warning of such approach, and the case was investigated by Army officials who found the Indian in the wrong. * * *

The Wire Section has had 'fun', though, if you want to call it fun or humorous incidents. On night one of the boys started to climb a pole and

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was nearly to the top when his hand came in contact with a rought moving object. Thinking the object was a snake, he jumped from the pole, without injury, and closer observation proved the 'cobra' to be a harmless lizard - the trouble-shooting continued. On another occasion, the men were shooting trouble on a line out to the base. The boys had never been out on this line previously, so they began walking the distance. Flashlights were at a premium and one of the men fell into a hole. He was fortunate enough to grab the root of a tree and pull himself up. More close examination revealed the hole to be an abandoned well, approximately 30 feet deep, with pieces of debris floating around in it. And then there was the case of the bats - one of the boys was up on a pole which housed one of our outside terminal strips and, upon opening the can, found three bats and a lizard all very indignant about the whole thing and aroused at the soldier boy's interfering with their home and 'young 'uns' - while our man became amazed at the advantages of a mere can on a pole. * * *

Relations among radio sections and our Allies have been very indirect. We have occasionally helped them with their equipment and when they lacked trained personnel, and we have handled communications for them. These have been, however, isolated cases.

Climate and terrain have been uncomfortable to all in the radio units because we've had to go to work in the heat and in the rain, and the road-riding has been none too smooth. Mechanics have had additional struggle of fixing keying lines in the mud, in the heat, and in the tangled undergrowth of the jungles. These repairing trips were made on several occasions only because some Indian, through ignorance or cussedness, slashed through the keying cable to obtain himself a piece of wire to use as a belt, a rope, line, or something else of an unimportant nature.

On the 15th of September we celebrated being together as a group of personnel for two years. We had, as individuals, been working and playing together for two years since the activation of the 390th Signal Company Aviation in Walla Walla, Washington of the fifteenth of September, 1942. At Camp Pinedale, California, we had been reallocated and assigned to the duties originally scheduled for the 413th Signal Company Aviation - they in turn, exchanged for our title and duties. Helping us to celebrate in the decorated mess hall was the Commanding General, Major General Curtis E. LeMay, and his executive officer, Brig. Gen. John E. Upston, and other high-ranking officials, intermingled with junior officers and men alike. It was a mammoth affair, and festivities ran on and on until the wee hours of the morning.

In October our first men were sent to Rest Camps at Ranikhet and Darjeeling, and closely following this procedure were men on furlough seeing the sights of India. Three day passes have been granted men every month since our arrival, and all men are given at least one day off a week, if possible, in order to prevent war fatigue. Our recreational program has been immense and successful - the softball team carried the base championship; the volleyball team came in a close second; we have entries in the boxing shows; and right now our two touch football teams are riding the crest of the upper brackets in the base league. Variety in entertainment is also our lot, and we provide men for musical programs in the area weekly. Our day room is the best on the post, furnished with one thousand dollars worth of fine furniture, radio, ping pong tables, public address system, etc., and we even pride ourselves of a bar in "Duration Den", as the recreational room is called. * * *



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*HISTORY FIFTH BOMBARDMENT SQUADRON HISTORY
1 December thru 31 December 1944

* * *

Seven days after the MUKDEN mission the second mission to be conducted in December was directed against the Rama VI RR bridge at BANGKOK, THAILAND. Briefing was held in the early evening hours of 13 December in the Group War Room. Little did anyone realize how disasterous the results of the mission would be as the primary target was announced. The attack would certainly not be a "milk run", but for crews who had seen the opposition the enemy offered over JAPAN and MANCHURIA the mission was more or less routine after the heavy take-off in darkness had been accomplished.

The mission began when the first aircraft was airborne at 1[illegible]Z. Twelve aircraft of which four were 45th Bomb Squadron planes took off, the last at 1321[illegible]Z.

Of the 12 aircraft airborne 11 proceeded as briefed to the primary target, but found that cloud cover obscured the target. No antiaircraft fire or fighters were encountered. Two bombing runs were made in an attempt to carry out visual bombing, but it was not possible to see the bridge, so the formation proceeded to the assigned IP (KAING'MAING ISLAND) for the secondary target, the Central RR Station and Yards at RANGOON, BURMA. An excellent bombing run was made in CAVU weather at 20,000' with "bombs away" at 0444Z.

Just a few seconds after bombs were away the formation was suddenly thrown into confusion and out of control by a violent explosion in the air. The cause of the explosion was not definitely identified, but all indications pointed to the fact that two or more of the 500 lb GP bombs had detonated a few seconds after they were released. Some crew members stated that intense predicted concentration of flak was seen at the same moment. Theory was also advanced that an Antiaircraft projectile might have made a direct hit on a bomb.

Regardless of the cause the occurience was a strange and a costly one. One aircraft was seen to flip over on its back and dived towards the ground in flame. Another aircraft had a wing on fire and was seen out of control. One aircraft is missing altogether and one is presumed to have been abandoned approximately 100 miles west of RANGOON. All aircraft that returned to base bore marks of damage.

The co-pilot of aircraft #608 states that he observed #601 flip over on its back beluching flame and out of control. Lt Col IRA COSGROVE, formation commander from the 44th Bomb Squadron in #709 reported that he was in radio contact with #674 directly after the accident. Capt ROBERT SHANKS of #674 wanted to bail out right away, but Col COSGROVE told him to wait until the last minute in an effort to get back to the coast. About 25 minutes after leaving the target area, Col COSGROVE was once again in contact with #674 at which time Capt SHANKS stated he was going to have to bail out and gave his position as approximately 100 miles west of RANGOON. There was no further contact.

Of the 11 aircraft over the secondary target of RANGOON, only two were

*History, 45th Bomb Sq, 1 Dec thru 31 Dec 44, 14 Feb 45 - Twentieth Air Force

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able to return directly to Base. Four aircraft were forced to land at CHITTAGONG due to battle damage, one aircraft landed at COX'S BAZAR and was further damaged when it ran off the end of the runway. Four aircraft, as stated before are missing. Aircraft #831 and #574 were lost from the 45th Bomb Squadron. Of the two other Squadron planes on the mission, aircraft #407 landed at CHITTAGONG and #859 due to loss of one engine bombed the last resort target at BASSEIN. Strike photos revealed excellent bombing results. No antiaircraft fire or fighters were encountered.

Members of the Squadron were stunned by the losses sustained over RANGOON and little, if any, solace was obtained from the post-mission photos, although it was revealed that excellent bombing had been done. A very compact pattern measuring only 1600' across was centered squarely on the yard. Damage resulting was heavy and included the virtual destruction of the RR station, four passenger loading platforms, five receiving sheds, and several small miscellaneous shops. Out of a total of 18 lines through the yard 11 were cut by one or more hits and the remaining were at least temporarily blocked by wreckage. Thirty-five rolling stock were either destroyed or damaged and 60 more probably damaged.

Photo cover of BANGKOK revealed that formations of the other three Groups in the XX Bomber Com and missed the bridge. Tothe 40th Bomb Group went credit for the only successful bombing of the day. * * *

With five missions completed for December all men in the organization tried to take their minds off of war and work for a while and looked ahead to Christmas. Colonel BLANCHARD declared Christmas Day a day of rest with no work call scheduled.

The Red Cross, Special Service Office and Lt Col SCHAAF, unit commander, combined scheduled events to make Christmas as nearly like home as possible. The Base Acappella choir composed of officers and enlisted men of various organizations on the field, including a substantial representation from the 45th Bomb Squadron, and directed by Miss Katie Harris, Red Cross Staff Assistant, presented a choral interpretation of the Christmas Story in the Base Amphitheater on Christmas Eve. The familiar notes of old Christmas carols in the clear night air struck a responsive chord in the hearts of most of those present, some of whom were spending their first Christmas away from home and loved ones.

A beer party was given for the enlisted men of the 45th Bomb Squadron and the officers enjoyed free beer and sandwiches at the Officer's Club. Colonel BLANCHARD, Group Commander visited with Lt Col SCHAAF and other Squadron officers and also dropped in on the enlisted men's party. During the few minutes Colonel BLANCHARD was with them all the men in the organization definitely decided that we have the best Group Commander in the whole Bomber Command while Colonel BLANCHARD couldn't hide his satisfaction with the gentlemanly, though noisy, conduct of our men.

Christmas Day saw church services and a hearty Christmas dinner of turkey, cranberry sauce, vegetable salad, mincemeat pie and all the usual trimmings of a holiday feast at home. Mess personnel put out a meal that was worthy of all the praise they received. In the afternoon athletic



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events took place with a softball game between the officers and enlisted men of the Squadron highlighting the schedule. Lt Col SCHAAF umpired the game and did a fine job considering the sun in his eyes and the distance he stood from the batter. Strangely enough the officers came out on the long end of the score.

On Christmas night a G.I. show was presented at the Amphitheater. The theater was packed and Sgt Joe Wagiot, operations clerk of the Squadron, had just stolen the show with his imitations when two bursts of heavy ack-ack shattered the peace of the night. The wail of a siren followed closely on the heels of exploding antiaircraft and all lights were extinguished on the Base.

No one wasted any time in seeking shelter in the numerous slit trenches all over the area, but to most of the men an enemy air attack seemed incredible after all the months the B-29's had been on the field. No bombs fell on Chakulia but frag bombs were dropped on the field at Kharagpur. The British operating the warning net for the area stated that six or seven unfriendly planes had been plotted into the area which later split up among the B-29 bases. As nearly as could be determined the closest to Chakulia was 10 miles. At any rate defensive measures proved good on the base. And so Christmas came to an end at Chakulia. * * *

"The Summing Up"

With December bringing 1944 to a close it seemed appropriate to look back into the past and to form any conclusions that could now be made as a result of time and experience.

The 48th Bomb Squadron received the first B-29 aircraft to come off the production line at Boeing's Wichita Factory in July 1943. Lt Col OSCAR B. SCHAAF, Squadron Commander, was checked off almost immediately and veteran pilots of the Squadron followed rapidly behind him to become first pilots. Those veterans were selected men from the Training Command, Air Transport Command and the old 48th Bomb Squadron.

But the selection of hand-picked men did not stop with pilots. Men of all classifications, that go to make up a tactical organization in heavy bombardment, were selected and in most instances given further specialized training in order to effectively handle the B-29.

The training program was rushed. A shortage of B-29's forced the use of B-17's as the plane that simulated flight conditions of the B-29 the closest. The knowledge of the weapon, that was impossible to gain in the States while training, had to be obtained from operation of the aircraft in a Theater of War.

Personnel and equipment were in place at Chakulia, India by the end of April. Flight operations began in May with cargo hauls across the Hump to the forward area field in China. Engines, spare parts, personnel, gasoline and a thousand different items were carried to China to set up the Base and to provide the materiel and personnel necessary to sustain combat operations staged from that point.

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The Hump became a proving ground for the B-29. Heavy aircraft loading and high temperatures of India on take offs, weather and hazardous terrain tested the pilot's skill on every flight, yet each flight was like a trip with an "unknown." Planes and men were lost over the Hump. However, no one could look back "hind sightedly" and say the losses were due to pilot error, because at the time the accidents occured the reason was that something happened with his new aircraft that the pilot knew nothing about. These flights, though produced a "know how" for the B-29. Emergencies and near accidents provided information on equipment failures and flight characteristics of the B-29 that led to needed modifications.

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*HISTORY OF THE 58TH BOMBARDMENT WING (H)

The beginnings of the history of the B-29 airplane itself were not auspicious. Death and destruction marked its debut.

At 12:09 p.m., February 18, 1941, Aircraft No. 1, XB-29 took off with a crew of eleven experts, all employees of the Boeing Aircraft Company, from Seattle, Washington, on an experimental flight. The flight, "to test power plant performance and cooling, propeller governing, airplane performance and two-engine ceiling," was to have endured three hours. It endured 17 minutes.

Weather was good; ceiling 9500 feet, visibility five miles.

At 12:16 the aircraft reported its position at Lake Tapps, 20 miles south of Boeing Field, at an altitude of 5000 feet, southbound.

At 12:21 it reported its position "south of Renton, at 2400 feet, descending," and requested landing clearance, as No. 1 Engine was on fire --"Propeller feathered; trouble not serious."

At 12:24 it reported its position over Lake Washington Bridge, altitude approximately 1800 feet. No mention of fire was made.

At 12:25 the Controller of the Seattle Tower overheard a member of the XB-29's crew remark to the pilot, Edmund T. Allen, on the aircraft's interphone: "Allen, better get this thing down in a hurry. The wing spar is burning badly," and Allen's unhurried request to the Control Tower to "Have fire equipment ready; am coming in with wing on fire."

This was the last word from the great aircraft. Forty-five seconds thereafter the electric power at Boeing Field failed. The airplane had struck a high tension wire, knocking out the system.

Fifteen seconds later the B-29 crashed into the fifth floor of the Frye Packing plant with all its weight of more than 100,000 pounds. The aircraft was destroyed. Its crew of eleven was dead. Any many employees of the packing house and several firemen died in the awful conflagration that followed.

Apart from the individual tragedies and private sorrows involved, the loss of the No. 1 XB-29 and its crew was a heavy blow to the men who had labored so long in designing, developing and building the giant bomber, and a severe setback to the men of the Army Air Forces who were counting on its employment in the ultimate discomfiture and destruction of the enemies of civilization. The death of "Eddie" Allen alone was a major catastrophe, for he was Boeing's best test pilot, possibly knew more about the infinite mechanical complexities of the aircraft he died in than any man that survived him, and the crew lost with him comprised the entire flight test section of the Boeing Company.

*History of the 58th Bombardment Wing (H), First Phase, Narrative and Appendix "A"

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The B-29 had been introduced to the Army Air Forces by the Boeing Aircraft Company in the spring of 1940. * * *

One incident of that long and painful period of preparation must be mentioned, however, since, had it resulted less fortunately, it would have delayed the whole B-29 program a full year and perhaps even have caused it to be abandoned altogether.

That was when, again at Seattle, by superb teamwork, great skill and quick thinking, the test crew of the second experimental B-29 to take the air narrowly averted for themselves and their aircraft a fate precisely similar to that of the XB-29 No 1 and its crew.

Of the original technical group, Harman, Olson, Morris and Grahame had been sent to Seattle to inspect and make initial test flights on the "second flying article," which was No 3 SB-29 airplane (No 1 having been destroyed in the "Frye Packing Plant disaster" and No 2 not yet being ready for test).

Just what caused the crash of the first experimental B-29 never has been fully determined--and never will be, since none of its crew survived. What so nearly caused the wrecking of the second was a curious mistake, due to carelessness on the part of some unnamed member of the airplane's ground crew--a mistake easy to make and difficult to detect--and perhaps fruitless to discuss at this late date, especially as no harm resulted. It is mentioned here not to fix responsibility, which, moreover, it is no part of this chronicler's task to assess, or even for the laudable purpose of illustrating for future generations of airmen the never-ending necessity of car in the preparation and inspection of aircraft for flight, but because what occurred that day, all in the unbelievably brief space of 30 seconds, so perfectly typifies the initiative, the technical capacity, the quick-wittedness and the team coordination of the officers and men that make up the technical staff and the combat crews of the 58th Bombardment Wing.

May 29 certain tests of the new XB-29 were to be undertaken; this time by an Army Air Forces crew. The tests embraced taxi runs, up to 95 miles an hour, and easing the airplane several feet off the ground to determine low-speed and ground-handling characteristics, including control effectiveness of the ailerons, elevator and rudder.

Subject tests began at approximately 2:00 p.m. The nose wheel was lifted from the runway at a speed of about 95 MPH and aileron test procedure was begun.

Colonel Harman was the pilot. He exerted a slight amount of pressure on the left aileron to determine reaction at this speed. This pressure unaccountable caused the left wing to start down. He applied corrective action, with the result that the bank to the right increased to about 30 degrees and the airplane changed direction to the right, heading for a large revetment on the field--and what appeared inevitably to be another tragic accident.

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Observing that the plane was rolling to the right, Colonel Herman cut Nos. 1 and 2 engines and and applied full power to Nos. 3 and 4 engines.

As flight of only momentary duration had been contemplated, the rudder power boost had not been engaged. Lieutenant Colonel Olson, the co-pilot on the test flight, "On his own initiative and without instruction from the pilot," (as the official citation recommending these men for decoration put it) engaged the rudder power boost at the correct instant, which assisted in righting the airplane directionally.

The crew chief, Master Sergeant James A. Grahame, realizing the plane was virtually out of control and that a crash impended, "on his own initiative and without instruction from the pilot," applied the emergency brake at the proper moment and in correct amount to bring the airplane to a stop.

The flight engineer, Lieutenant Isaac Drew Morris, at his station and riding backward to the direction of flight, likewise conscious of the danger that threatened, prepared the engine controls for emergency action and, sensing the possibility of fire in the engines, in the light of past performance of similar engines, put the fire emergency equipment in readiness and cut off the engine ignition when the wheels touched the ground and the plane once more was under directional control.

A motion picture record of the test shows the extremity of the danger that confronted the crew of the No. 3 XB-29 on this test run and the hazardous obstacle they surmounted while covering a distance of but 6000 feet from the point of departure to the complete stop. The right wing had cleared the revetment by a matter of feet. The concerted, almost automatic safety measures of the crew members to avert the wrecking of the plane were taken in less than half a minute.

An inspection made on the flight line, after the passengers had climbed from the craft and for a moment "look'd at each other with a wild surmise," revealed the trouble. The aileron controls had been hooked up in reverse.

* * *

Following the "near catastrophe" of May 28, XB-29 No. 3 was back in commission by June 6th ready once more for its test flights. On the very first of these - to the consternation of everyone and the vast discouragement of the Boeing People, an engine was lost, and there was more, though less serious, engine trouble on the second flight. "The No. 3000," to employ the colorful vernacular of the period, was "in the doghouse" again. So, for that matter, were its makers, the Wright Aeronautical Corporation, which for some time had been a target for the Truman (Senatorial) Committee's sharp criticism.

It is not the province or the purpose of the present chronicler to discuss the merits of that controversy. For the purposes of this account, it is sufficient to state that General Echols, taking cognizance of an unsatisfactory situation as regarded the progress of the B-29 project, found it necessary to appoint a committee of Materiel Command experts to pull the "3000" out of the doldrums.



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The 3350 was a new type of engine, designed for the B-29. It had passed all necessary tests, had undergone various redesigning and retesting, and been found ready for combat use, but for many reasons not pertinent to this record its production was far from adequate. * * *

To return to our muttons, on the third of the renewed test flights at Seattle in early June, no engine trouble developed and the Boeing people began to take heart again. Thereafter the plane was kept at Seattle until it had been flown 10 hours, when it was decided it would be safe to take it to Wichita, Kansas, for flight testing.

Preparations for the production of the B-29 went on apace with the completion of the design of the airplane, and the factories, machinery and tools for its manufacture. Following the successful test flights at Seattle, XB-29 No. 3 was flown by a test flight crew from Seattle to the Army Air Field at Wichita, with Colonel Harman as pilot. (Early in July it was flown to the Army Air Field at Marietta and there decommissioned for the purpose of installing Sperry Armament equipment in preparation for firing tests at Eglin Field, Florida.)

About the time the test flights were being conducted in Seattle, General Wolfe ordered Colonels Moore, Couch, Robey, and Russell and Major Neffler to proceed to Marietta, where it was proposed to establish the headquarters of the 58th Wing; Moore and Robey continuing on to Wichita, to join Harman and Olson and conduct the next phases of the development - the flight testing of YB-29, the accelerated service testing and production of YB-29s and B-29s and the testing of the 3350 engines.

Early in June the first YB-29, which was representative of the "production B-29," was ready for flight. With Colonel Olson, Captain Morris and Sergeant Grumane as his crew, Colonel Harman made the first test flight of this airplane at Wichita, June 18. On the first take-off there was an oil-line break, which worried everyone because they thought it was another engine fire, but the trouble proved to be no more than a leaky gasket, and on the second flight, made next day, the airplane functioned satisfactorily, except for a minor rudder difficulty. During that flight, which lasted approximately an hour and a half, enough information was obtained to give the "green light" for production.

There followed a month's period of testing by Colonels Harman, Moore, Robey and Olson, of the various components of the airplane--rudders, propellers, electrical system and so forth--looking to change and modification to make a better flying aircraft, though without interference with the "full speed ahead" production schedules.

One of the first things that had to be done to enable design, manufacture, testing and training to proceed effectively and concurrently, was to train additional pilots, both Army (for acceptance testing) and Boeing (for experimental testing), because the third and last experimental article, known as the YB-29 No. 7, was to be a fully instrumented airplane from which all flight test performance data necessary to determine the B-29's combat capabilities could be obtained.



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When this third experimental plane had been shaken down and proved airworthy, it, in turn, was flown from Seattle to Wichita, and 40 of the Boeing Company's flight personnel were brought to Wichita for crew training under Colonel Olson and Colonel Harney Mates, of the Flight Test Section of the Materiel Command, Army pilots being trained simultaneously to take over acceptance testing. Meanwhile, Colonels Moore and Olson continued with the early phases of production testing and the acceptance testing of the first planes until they were moving.

In July, 1943, just two years after ground had been broken for the factory at Wichita, the first production article of the B-29 type was turned over by the Boeing Company to the Army Air Forces and flown at the Wichita Army Air Field by Colonel Harman.

In August, Colonel Moore delivered this airplane to the Bell Bomber Plant at the Army Air Field in Marietta. This was the first cross-country flight of this aircraft with a tactical crew, made up of tactical squadron crew members - the nucleus of all the tactical crews of the 58th Wing to come. There it was promptly decommissioned for installation of the General Electric Remote Control Armament. * * *

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*HISTORY OF HEADQUARTERS SECOND AIR TRANSPORT SQUADRON (MOBILE)

1. At 0001, April 22, 1944, the Second Air Transport Squadron (Mobile) becams activated, to begin her helping hand in the war effort of the United States of America. Lieutenant Colonel Clyde A. Ray assumed command of the Squadron at Homestead Army Air Base, Homestead, Florida on the above date.

Little did the men realize that, as of that date, they were destined to see practically the whole world.

While activation date was April 22, 1944, plans and personnel were moulding into this day practically one month previous. Flying Officers, Ground Officers, Crews, and all types of personnel that go to make up a flying unit were called in from all over the United States to become part of this unit which was and is destined to play an important part in the overall war effort of the United States Army Air Forces.

Men began trickling into Homestead Army Air Base, Homestead, Florida from the fifteenth of April on till the fifteenth of May.

Before the Commanding Officer lay the tremendous task of moulding a unit together within thirty day. Could it be done? To take three hundred and fifty men who had never been together before and weld them into a unit able to go over seas and do her part in the war effort seemed an impossible task. It had been done but once before. Well it could be done, as was and is being proven every day since that eventful April 22, 1944 when the Second Air Transport Squadron (Mobile) began its' historical career with the United States Army Air Forces.

And so begins the saga of the Second Air Transport Squadron (Mobile).

2. Our first month we will call chapter number one, which, deals with our tenure of duty in the states, the formation of our unit into a smooth working organization.

Squadron Headquarters was set up in one of the buildings easily accessible to all. Squadron Operations under the very capable leadership of Captain Frank Sylvester and Captain Robert Hawley was set up in the Base Operations Hangar.

The first few days took up processing and was a rather tiresome if not monotonous job. Soon the Squadron began to take shape and look like an organization rather than a group of men wandering aimlessly about without a definite purpose in mind. A large amount of credit for this can be given to Captain Ralph L. Stevenson, the Squadron Adjutant. Within two weeks he had performed the almost unbelievable task of having three hundred and fifty men working together as a very efficient unit.

Life at Homestead, Florida was very interesting and always we were at an edge waiting for the day that would eventually come, D-day. Everything possible that we might need overseas was thought of. A washing machine,

*Headquarters, Second Air Transport Squadron (Mobile) dated 15 August 1944

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in the event that we should be someplace without facilities for washing our clothes, a refrigerator, pressure cookers, Special service equipment and countless other things that would make life easier. The Lucky Strike Corporation gave us two hundred thousand cigarettes. On the seventeenth of May, the Officers held a final shindig and get together at Winnie's Riptide in Miami Beach. An what a time was had by all! The enlisted men were also given special passes and transportation into Miami for their final blowout in the States. After this date we were restricted to the Base and we knew that D-day was not far off. Much hustling and bustling around took place. Lt. William Davis took a trip to Ohio for Tech supplies. Ships were going all over the states picking up our last minute wants.

And then on the twentieth of May we were alerted for immediate shipment overseas. And so it goes. Twenty four hours later the orders came and after Church services at midnight, twenty C-46s' with Lieutenant Colonel Clyde A. Ray at the helm lined up on the runway at 0200, May 22, 1944, ready for the unannounced destination. Engines were started; they spit and they fumed, as if to show that they were mad at leaving the states, and still madder at the enemy that they were soon to run across.

At precisely 0200, Lieutenant Colonel Ray's ship sped down the runway, ready for the longest single, complete, thorough movement in the history of the Army Air Forces. In but a few seconds he was on his way, circling the field and off into the darkness of the night. For the next one hour and forty minutes (every five minutes) a Second Air Transport Squadron (Mb) C-46 took off for an unannounced destination. Rumors were rampant as to where we were going. It could be India, it could be Europe, it could be Russia. No one knew but everyone felt that they had the right idea. And then to our great surprise our pilots opened up the secret orders and we were destined for Deversoir, Egypt. Many many thousands of miles away. It seemed as though all the things we had read and heard about from the time we were eight or nine years old were going to unfold right before us. Truer words were never spoken.

And so begins the second chapter of the saga of the Second Air Transport Squadron (Mobile).

3. Our first leg of the journey was from Homestead, Florida to Borinquen, Puerto Rico. And even though with approximately twenty men to a ship already fully loaded down with equipment, the ride was very confortable. Both officers and enlisted men were more than pleasantly surprised with Borinquen and a very enjoyable relaxation period was had by all. However it was not to be our fortune to spend any more time than necessary at any stop along the route. And at 0200 the following morning we were winging our way once again to Atkinson, British Guiana. From there we sped onward to Belem, Brazil and from there to Natal. And then we all realized that the coming hop was the most exciting. We held our breaths, as here was the hop that everyone talked about but few had had any experience with it. It was to be a hop over nothing but water from Natal, Brazil (the jumping off spot) to the "Rock". Ascension Island, somewhere out in the middle of the Atlantic Ocean. The fact that but a few months previous this trip would have created history did not phase any of the men whatsoever. Everything was being taken in stride. The Pilots were as cool as could be. Their coolness gave a note of confidence to all the men who did not have the knowledge of what a tremendous hop this was to be. Well, twenty ships took off from Natal, Brazil

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beginning on the night of the twenty fourth and twenty ships hit the "rock" right on the button the following morning. Remained there but long enough to gas up and away we were again. This time our destination was to be Accra. Also a very long hop over water. Accra was the first stop in what we would all term the foreign lands. It was on the Gold Coast of Africa. From there we took off for Maduguri. This leg nearly proved to be fatal and was our only mishap of the whole journey. Six of our planes were told to land at Kano. This took place at about 1000 on the twenty seventh of May. At 1400 we were told to proceed to Maduguri and join the rest of our Squadron. While on the runway, one of the ships got out of control and careened madly down the runway. Lieutenant Frank Arlaskas proved the first hero of our unit when he succeeded in getting his ship out of the way of the oncoming monster and saving forty lives in doing so. No one was injured, thanks to God, and we continued on our merry way. We spent the night Maduguri and the following day visited the native town. It was very interesting but we all hoped we were not going to be stationed near such a village. The following night we took off for Khartoum, Anglo Egyptian Sudan. And from there we were to leave for our final destination. Without an illness, without a serious mishap, the following day we arrived at our final destination, Deversoir, Egypt. Exactly nine days from leaving the United States of America. History had been made and the United States Army Air Forces had one more unit to be exceedingly proud of. So ends the story of the first long journey made by the Second Air Transport Squadron (Mobile). We jumped out of the ships, happy that our trip was over and were ready to settle down to a calm army life on the banks of the Suez Canal, not far from Cairo. But we were to be agreeably or disagreeably surprised in the near future.

So begins the third chapter in the short but exciting life of the Second Air Transport Squadron (Mobile).

4. Deversoir is known as the Country Club of the Middle Eastern Theatre. That it was. The weather was temperate. Swimming was in order daily in the Suez. A shuttle ran twice daily to and from Cairo. We were all able to see the pyramids and other main points of interest and education.

Within forty eight hours after landing we were operating efficiently as a Squadron. Movies were held nightly in an open air theatre. The Red Cross served coffee and doughnuts nightly to the enlisted men and they had an excellent Service Mens' club. The morale of the unit was very high. The Officers' had a fine Officers' club. All in all it was a splendid set-up.

However there was still a question as to what and whereto our mission might be and where it would take us. The Commanding Officer went to Casa Blanca to secure information regarding our mission but reached no definite conclusion. And then tragedy struck in a mild manner. One of the enlisted mens' barracks burned to the ground destroying all their personal belongings. Here the Red Cross came to our help and secured the men the necessary toilet articles and items that were sorely needed. Mail became muddled up, due to APO changes and we did not receive mail for many weeks. Still the morale remained high. Then when everything was going smoothly, one evening about

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2100, orders came to proceed to Kalaikundha, India to carry out our mission. That night proved to Lieutenant Colonel Clyde A. Ray and to all others interested in the welfare and guidance of the Second Air Transport Squadron (Mobile) that we were realy an efficient, smooth working organization. We completely loaded our ships that nigh in the darkness and bid farewell to the wonders of Egypt that following morning. A perfect take-off was made and we were no enroute to the land of mystery and enchantment. So concludes the third chapter in our Squadron memoirs.

5. The trip to Kalaikundha, India was uneventful with the exception of two historical sights. That of the Holy Land and flying over the Taj Mahal. We stopped at Iran and also at Karachi, India. Then from Karachi, India we headed for our final destination (temporarily). En route Captain Jules Prevost, our genial engineering Officer, became quite ill and for a few days it seemed as though we were going to lose a very good and valuable man. However good fortune stayed with our unit, as it had from the day we activated and he rejoined us once again in perfect health.

So begins the fourth chapter in the exciting travelogue of the Second Air Transport Squadron (Mobile).

6. Life came to Kalaikundha, India on the fourteenth of June, 1944. Things were in a great muddle upon landing. First off, we did not know where we were going to "chow", second we did not know where we were going to sleep; and happy memories of the States and Deversoir were running wildly through our minds. So we bitched and we moaned as all soldiers are expected to do and proceeded to get our chow and find a place to sleep. That was our first experience in Kalaikundha.

On the following day we proceeded to start the ball rolling. Squadron Headquarters was set up on the line as was operations. A branch exchange was set up where a man could cool his whistle after an extremely warm day of work. Some of our early days in Kalaikundha were spent under a temperature of 130 degrees. Within a couple of days things were back to normal and we were once again operating as efficiently as conditions would warrant. The Engineering section was operating twenty four hours a day to "keep em flying" and our mission had begun. Constantly there was traffic from here to Chengtu, China via the "Hump." Within a matter of but a few weeks our Squadron had surpassed the record of any previous organization. In most cases it was the most thrilling experience the pilots and crews had ever had. Flying over enemy territory with the possibility of a few Zeros on your tail was and is no joke. The first mission of the Second Air Transport Squadron (Mobile) was and is to carry fuel and supplies to China. The main item is gasoline. Generally the men make five consecutive trips over the "Hump" and then back to Kalikundha for a brief rest. The system has since been changed whereby the men go direct from here to Jorhat and then over the "Hump" to China and after a ten hour rest period, return to Kalaikundha, where they are made ready for another trip over. A mild epidemic of malaria broke out amongst our radio operators and five of them were knocked down. Our Flight Surgeon, Leslie M. Lisle, has done an exceptional job in the medical care of our organization.

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And then the "Rains Came". What we had read about in the sixth and seventh grades in our geography classes about India and the Monsoon; finally came to pass and realism was once more brought before our eyes through the mysterious life of the Second Air Transport Squadron (Mobile). It rained and rained some more. Some of the tents were flooded away. But still we came back for more and then we were given the order to move to a new area on the field. Once again our mobility was proven and we set ourselves up in quite fashionable quarters. At present date things are running smoothly. But two ships have become Class-26 in our operations over the "Hump". We are hanging up a record over all operations that will undoubtedly never be surpassed. All the Pilots want, is to be able to keep flying. They would fly twice as much if they were allowed to. And so this date, just one week lacking four months of our activation of the Second Air Transport Squadron (Mobile) we take leave temporarily of the thrilling saga of the greatest mobile unit in the United States Army Air Forces today.

s/ Horace H. Gaffney
t/ Horace H. Gaffney
1st. Lt. A. C.,
Historical Officer

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*HISTORY OF HEADQUARTERS SECOND AIR TRANSPORT SQUADRON (MOBILE)

The (Mobile) seems to have left our address and we have become more or less permanent party at Kalaikunda Army Air Base. So be it; we have become accustomed to staying in one place and as the field has changed considerably for the better since we have arrived, we have no complaints.

During the month of August our total trips over the "Hump" fell to 155 trips. Our previous trip total for a month had been 206 trips. The reason for the drop is due to the fact that the length of our missions had been increased approximately 40%. Instead of loading at Jorhat and taking our load over, we were loading at our home field and just stopping at Jorhat long enough to gas up. This met with disapproval in many minds but to no avail. So we continued on fulfilling our mission and doing an excellent job.

As we are now in the midst of our mission for the USAAF, it would be well at the moment to give a little description of the actual mission that a crew participates in. The usual hours of takeoff from Kaliakunda are from ten at night till ten in the morning. The crews are awakened and given one hour to report to operations. Their ship is fully loaded with the gasoline they are taking to China and after clearing through Base Operations they are ready to go. Actual flying time of this mission from Kalaikunda, India to Tsinching, China is approximately 9 hours and 30 minutes. The usual route is from here to Jorhat where the ship is gassed and the crew usually stop and eat at the line mess. This takes about an hour. And then the takeoff to the final destination. The total time for Jorhat to China is apporximately 5 hours. About 30 minutes after takeoff, the crew put on their oxygen masks and from that time until reaching China about forty minutes from destination they are worn. Usual altitude for flying is approximately 16,500 and it gets extremely cold. Sometimes you fly at 20,000 and over. It is the most thrilling, hazardous journey in the effort of the USAAF today. Nearly all the time you are flying on instruments and are not able to see a thing. The clouds come in handy however, as there is always a possibility of meeting a Jap. It has happened. Some of the thrilling experiences that have happened on the Hump are having both engines cut out. Through the Grace of God, however, they come back in. Secondly, icing up to such an extent that you are constantly losing altitude and have to throw your drums of gasoline overboard. It is something you will never forget, to see the crew tie themselves to the side of the ship at 20,000 feet and open the hatch and start rolling these big drums of gasoline overboard. It gives one a feeling of apprehension to be at 20,000 feet and seeing the boys throw off the pay load. It makes you wonder if now the time has come and you are going to have to bail out. That is a feeling--20,000 feet, ice cold, breathing from an oxygen tank and wondering whether you are going to parachute through that cold thin air. So far after 532 trips over the Hump to this day, we have not had to jump. Thank God and may it continue. Upon arriving at the field, known as A-1 in China, we are met at the ship with transportation to either the mess or the Hostel in which we stay. On first making these trips, the boys could hardly get there fast enough in order to have some of the "eggesses" that have been sadly lacking since leaving the States. Also one of the features at this field is the hot shower you are able to take. A Chinese coolie fills five gallon bucket with hot water, and then you turn on a sprinkler system on the bucket and get a nice warm shower. Then for

* History of Headquarters Second Air Transport Squadron (Mobile) dated 26 September 1944

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the Pilots and crew it is usually time for relaxation. They usually "hit the sack" or play some poker and as a rule, in the evening, there is a movie. Some of the boys go into one of the villages close by. That is, Old Tsinching just off the runway, or New Tsinching which is across the river and is only reached by taking a sampan over the river. Both these villages are interesting and an education to us who are fortunate enough to visit them. There is one nice place to eat in Old Tsinching called the "Stork Club," very different from what we have at home but them it is diversion. You are able to get roast duck, roast chicken, chow meins, and those that wish, can partake of the old "liquid spirit" in the form of Chinese wine. It isn't too bad but due to its sweetness you do not drink much of it. The Chinese are very friendly to us and constantly put their thumb in an erect position and give us Ting Hao (Very Good.) Then upon darkness, the boys return to their hostels and go through once again the same routine that takes place over on this side of the Hump. Those that are "going out" are usually awakened anywhere from three until six in the morning and prepared for takeoff. If you are fortunate enough to leave in the early morning just before or at sunrise, you get the thrill of your life. It is usually clear and the scenic beauty is more than this writer can express. The mountains that seem to touch the sky, covered with snow and ice look like diamonds sparkling in the early morning sun. You see little villages or a single hut on the top of a cliff or peak and you wonder how on earth those people living there get supplies or how they live. Some of them, undoubtedly, have never visited civilization. And still life goes on. You see the winding rivers many thousand feet below that look so small that they resemble creeks that you used to look for pollywogs when you were a youngster. On a clear day it is very seldom that a trip gets monotonous. If there is ever a Shangri-La in this world, our boys fly over it. Then after about four hours on the return trip you land at Jorhat and once again are prepared for your last leg home. The average of our pilots in trips over the Hump so far runs about 25 trips which is a tremendous average.

Only second to the thrill of flying the Hump comes the thrill of flying "special missions" from our base at Tsinching, China on up into the advanced forward area. These missions run practically to the Jap lines. It takes a tremendous amount of courage to fly our ships (without guns or armor) into nearby enemy territory and always the possibility of being attacked by enemy aircraft. Lts. Grossoehme, Paxton, Klasmier, Arlaskas are just a few of the pilots who have flown to within a few miles of the Jap lines to take supplies and parts, thus enabling another wounded super-fort to again be airborne for another raid. One of our C-46's has been hit by Japanese bombs and its wings were badly shot up. However, at this writing, it is airborne again.

We would like to take time for a moment to pay the pilots and crew members a tribute.

Seldom, if ever, in the history of all the Air Forces of the world, have a group of men undertaken such a dangerous mission. It seems nearly impossible that a man has so many qualities and steadiness about him that he can go on taking these trips day in and day out. No signs of fear, although apprehensive, they are always smiling as if they can't wait the thrill which awaits them on every trip.. There is always something new.

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The round-trip is approximately 20 hours and about 18 of them are under constant pressure. But our boys, each and every one of them are unquestionably some of the greatest pilots in the world today. Our hat goes off to each and everyone of them in extreme admiration for the remarkable sincere job that they are doing to preserve the type of life that we love to live. We are very sure if the people back home knew the extreme hazards that these boys are under, the fellows would be the cream of the Air Forces upon their return home to the States. We can't express fully the admiration that we all have for them.

Now back to the Squadron. On the first of September, the enlisted men had a grand opening of the Squadron club. Here they serve drinks and it given the boys a chance to relax after a hard days work. Everyone has settled down to a normal daily routine and the morale of our unit is just about as good as any unit in this or any other theatre. Everyone gets along well. There is a very friendly feeling between the Officers and Enlisted Men. Sport between them are always excellent contests to watch. The men have a fine day room and all in all there is not much that the boys could want.

Effective on the first of September, all our first pilots became First Lieutenants, Capt. Hawley, Chief Pilot, was promoted to the rank of Major as was Capt. Frank Sylvester, our genial Operations Officer. Two ground Officers were also promoted; 2nd Lt. W. Simmons and 2nd Lt. Walter French became First Lieutenants.

As always, a bit of sorrow is intermingled with all your happiness to make life what it is. And sorrow and tragedy struck our Squadron on the 8 Sept 44. Lt. Dave Hayden, Pilot, F/O Francis Johnson, Co-Pilot, S/Sgt Okie Venable, Crew Chief, Corporal Charles Cooper, Radio Operator, and Corp. Paul Kenny, Ass't Crew Chief took off on a mission from Kalaikunda to China in the early morning hours of 8 Sept and have never been heard of since. A finer crew was not in our organization, and while they are probably in another world today, they live keeply in the hearts of the men in the Squadron. Undoubtedly they have joined other Air Heroes who have given their lives attempting to secure and preserve the happiness of their fellow men. There was a bit of irony to this tragedy. Corporal Paul Kenny, Ass't Crew Chief, had never taken a trip over the Hump. And as far as he was concerned, he wasn't. And then, as all men are, he wished to secure the thrill that his fellow friends have had and decided to take that journey which was to be his last. And so to you five men who have gone to the land where you can watch over our men who are flying, we will never forget you, and thanks from the bottom of our hearts for helping us fulfill our mission in this great struggle.

On the twenty-second of September, the base opened the base Officers' Club. We had all contributed 30 rupees for its building and it is really worth considerably more. On this night, once again, the Second Air Transport boys got together and really had a good time. We are now entering our sixth month since activation and fifth month overseas, and we can truthfully say that a better bunch of fellows could have never gotten together in one group. Occasionally there is bitterness and sarcasm, but show us a group of men that doesn't happen with. And yet, even though there is an occasional outbreak, pinned down, every man in the squadron would do anything for each and every



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man in it. We are all just a group of men banded together to do a job (our part in this evolution of history) and we feel that under the leadership of our Commanding Officer that we are doing that job.

s/ Horace H. Gaffney
t/ HORACE H. GAFFNEY,
Lst Lt., Air Corps,
Historical Officer.

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5 January 1945

*NARRATIVE HISTORY OF HIJLI BASE AREA

* * *

The official opening of the Red Cross Service Club was on July 4th, after more than two months of actual functioning of the club without canteen, program, electricity, adequate furniture,--and with very few customers. Due to the monsoon rains Brig. Gen. K. B. Wolfe was unable to formally present the Club to the enlisted men, and the orchestra, which came from Calcutta for the occasion, was unable to put on its planned program. However, the first dance for the enlisted men on the base was held that night in the three main rooms of the club, partners being local girls who were well chaperoned.

The Bomb Bay, officially named as a result of a G.I. contest, became, a few months after its inception, the largest Red Cross operation in the theater. After the formal opening of the Bomb Bay's doors, a program of bingo, current events talks, including one by Lt. Col. Vincent Sheean, pinochle and bridge tournaments, pingpong, and the weekly Sunday morning Coffee Hour became fixtures.

Of the several talent shows produced in the movie theatre, in October the show "So This Is India" received the greatest ovation. The cast, including fourteen members of the newly-formed, still-rehearsing XX Bomber Command Band, accomplished a 2½ hour show, written by Sgt. Andy Shook of the 793rd Bomb Squadron and directed by Pfc. Sid Irwin of the 10th Photo Lab, who was also the laugh riot of the show as a WAC. The show played to approximately 3400 men in three programs, two on this base, and one off the base.

The dance band, organized by 1st Lt. Johnny Adams, was formed from men of this base in October. In their spare time the fourteen members, with the cooperation of Special Services, soon became the most sought for entertainment unit on the base.

Among other activities, the Christmas Dance, held December 23rd, on the outdoor dance floor with music by the now-very-accomplished XX Bomber Command Band was probably the most ambitious effort of the new entertainment committee. The Special Service Section built an orchestra shell, put up the lights, and helped with the decorations. The shell was constructed with salvage airplane parts, and served the purpose very satisfactorily. Light reflectors were made of salvage gun blisters.

Much can be said about the reception of American ideas by the Indians. One of the most comical was the Christmas Tree incident. Three trees arrived at the Bomb Bay, all fresh and green from Darjeeling, about a week before Christmas. The storekeeper (an Indian) had them unpacked and issued orders which resulted in the bearers cutting them neatly in half and planting the halves in the garden in front of the club. They were ultimately dug up again and nailed together by the carpenters, but never looked quite the same.

*Narrative History of Hijli Base Area, COMD-BOMB-20-HI, 1 Feb 1944, Twentieth Air Force Materials.

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The first religious services on the base was held on Easter Sunday, 9th April, when Lt. Col. Kenneth G. Stack, Command Chaplain, said Mass. The following week, 16 April, Captain Jesse L. Coburn Jr., the chaplain of the 468th Bomb Group led the first Protestant worship. Jewish services were held for the first time on 23 July, when 1st Lt. Dubin, chaplain of Base Section No. 2, S.O.S., Calcutta, visited the base.

The early Protestand and Catholic services were held in a bare prefabricated building in the compound area. On 1 May they were moved to the new chapel located a short distance southeast of the compound. The chapel is a refurnished barracks that is beautiful and inspiring in its simplicity--a maroon backdrape contrasting with the pure white of the altar, the pulpit, the rail, walls and pews. A carpet runs the full length of the center aisle and strips of carpet are laid between the pews.

The Non-commissioned officer's club was organized in April 1944. An election was held and T/Sgt (then S/Sgt) Gerard Dempsey was elected to serve as President. Through the cooperative efforts of all NCO's of the club an unoccupied mess hall was converted into the clubhouse of the noncoms. The building was adequate in size only. The interior had to be completely rennovated. New windows were cut in the building, screens were placed on doors and windows and walls were draped with pleated burlap to within three feet of the floor. The lower three feet of the walls are covered with split native bamboo which has been highly varnished giving off a beautiful lustre.

The bar is semi-circular, more than twenty feet in length and of solid native stone and cement construction. Immediately in front of the bar is a conical shaped fish pond ten feet in diameter. The club is comfortably furnished with large divans, studio couches, large easy chairs, end tables and stools. A new piano was recently purchased and a musical entertainment is usually on the program nightly. Recently through the efforts of the "Board of Governors" and the Base Commander an adequate snack bar has been added to the clubs' facilities. * * *

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This booklet is presented to you by MARIANAS-BONIN COMMAND, The TWENTIETH AIR FORCE, and MARIANAS AIR MATERIEL AREA for your use during your visit on Guam and as a permanent record to take with you.

Willow C. Morse
Commanding General
Twentieth Air Force

Arthur Thomas
Commanding General
Marianas Air Materiel Area

H. B. Bradley
Commanding General
Marianas-Bonin Base Command

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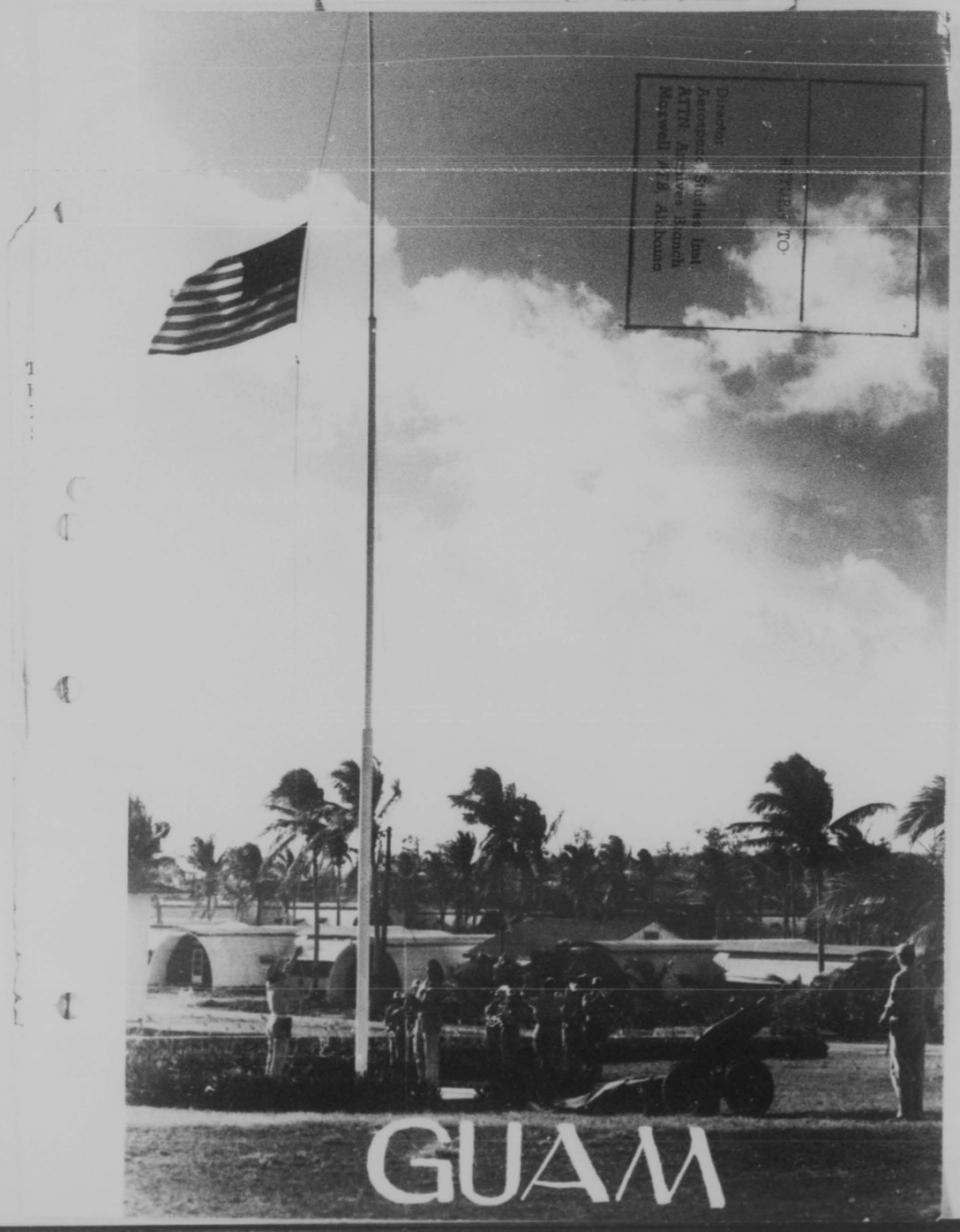


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# The BATTLE for GUAM

Guam, largest of the Marianas Islands, is situated little more than 1500 miles from Tokyo. The island, about 32 miles long and 4 - 10 miles wide has an area of approximately 225 square miles or about three times that of Saipan. Due to its size, good harbor, and strategic location, Guam became the most important single island on the road to Japan and ultimate victory over the Japanese. Headquarters for Fleet and B-29 operations in the Pacific, it has three large Superfort bases and numerous Naval Air Fields.

The battle for Guam, though not the toughest in the Pacific, was one of the most important waged by U.S. Soldiers and Marines. Units and commanders participating in the Guam campaign were as follows:

COMMANDER OF AMPHIBIOUS OPERATIONS
Rear Admiral Richard L. Connolly

COMMANDER, THIRD AMPHIBIOUS CORPS
Major General Roy S. Geiger

THIRD MARINE DIVISION
Major General H.A. Turnage

FIRST PROVISIONAL MARINE BRIGADE
Brigadier General Lemuel P. Shepherd

SEVENTY-SEVENTH ARMY DIVISION
Major General A.D. Bruce

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# The B-29s ON GUAM

12 APRIL 1944
Engineer representatives of XXI Bomber Command make first survey of Guam for B-29 bases. Accompanied by General Harmon.

6 SEPTEMBER 1944
Clearing of Depot Field (later Harmon Field) began. Later set up for B-29 operations. Roadnet from first major strike landed there to ease traffic at Isley Field, Saipan.

10 NOVEMBER 1944
Clearing operations for first runway on North Field began.

5 DECEMBER 1944
Later echelon of XXI Bomber Command Headquarters arrives at Guam.

3 FEBRUARY 1945
North Field opens.

8 FEBRUARY 1945
First B-29s land at North Field.

25 FEBRUARY 1945
Sixth Wing flies first mission to Japan from North Field.

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## The BATTLE for

5 JULY 1944 Record Naval Air and Sea bombardment begun. This continued

1ST PROVISIONAL MARINE BRIGADE AND 77TH ARMY DIVISION.

22 JULY - Land at Agat against light opposition. 22 JULY - Beachhead expanded following Jap Counterattack. Take Mt. Alifan. 23 JULY - Southern beachhead expanded well into interior and toward Apra Harbor. 24 JULY - 2500 Japs cut off on Orote Peninsula. 25 JULY - U.S. Forces join to control 12 miles of coast.

26 JULY - Desperate Jap Counterattacks repulsed on Orote Peni... Marines in advance to Sumay. 3rd takes slow progress after J... American flag raised on Mt. Alifan. U.S. sovereignity reesta... 77th troops advance to a mile inland east of Bangi Point. 3r... Agana. Troops in center smash through to take Mt. Tenjo. ... Mopping up begins. Patrols cross to east coast without meeti... break through on large front on east coast. Small pockets o... patrols. The main Jap force had retired to the North. Agana ... east coast advance rapidly. 3rd forces are at outskirts of A... tion on Mt. Santa Rosa bombed and shelled. 2 AUGUST - Ag... towns fell. Mopping up continues on southern end of island. ... U.S. troops advance 2-4 miles per day. 7th takes Mt. Barriga... Stiff resistance is met at Mt. Santa Rosa. 8 AUGUST - Mt. S... vance is made to within one mile of north coast. 9 AUGUST - ... Japs from Point Ritidian. 10 AUGUST - Small pocket of Japs ... ized Jap resistance ends at noon on 10 AUGUST 1944.

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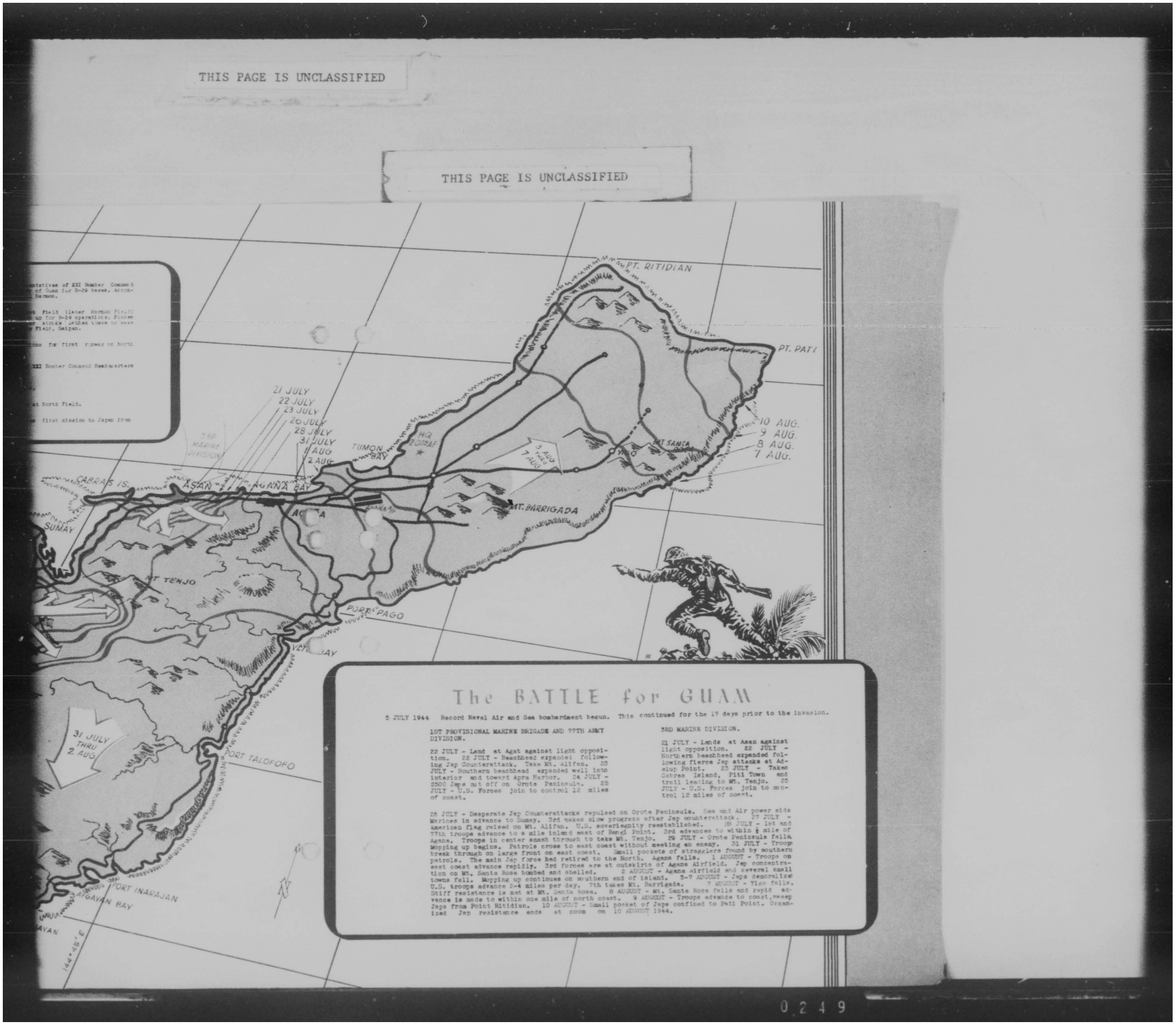


## The BATTLE for GUAM

5 JULY 1944 Record Naval Air and Sea bombardment begun. This continued for the 17 days prior to the invasion.

1ST PROVISIONAL MARINE BRIGADE AND 77TH ARMY DIVISION.

22 JULY - Land at Agat against light opposition. 22 JULY - Beachhead expanded following Jap Counterattack. Take Mt. Alifan. 23 JULY - Southern beachhead expanded well into interior and toward Apra Harbor. 24 JULY - 2500 Japs cut off on Orote Peninsula. 25 JULY - U.S. Forces join to control 12 miles of coast.

26 JULY - Desperate Jap Counterattacks repulsed on Orote Peninsula. Sea and Air power aids Marines in advance to Sumay. 3rd makes slow progress after Jap counterattack. 27 JULY - American flag raised on Mt. Alifan. U.S. sovereignity reestablished. 28 JULY - 1st and 77th troops advance to a mile inland east of Bangi Point. 3rd advances to within ½ mile of Agana. Troops in center smash through to take Mt. Tenjo. 29 JULY - Orote Peninsula falls. Mopping up begins. Patrols cross to east coast without meeting an enemy. 31 JULY - Troops break through on large front on east coast. Small pockets of stragglers found by southern patrols. The main Jap force had retired to the North. Agana falls. 1 AUGUST - Troops on east coast advance rapidly. 3rd forces are at outskirts of Agana Airfield. Jap concentration on Mt. Santa Rosa bombed and shelled. 2 AUGUST - Agana Airfield and several small towns fall. Mopping up continues on southern end of island. 3-7 AUGUST - Japs demoralized U.S. troops advance 2-4 miles per day. 7th takes Mt. Barrigada. 7 AUGUST - Yigo falls. Stiff resistance is met at Mt. Santa Rosa. 8 AUGUST - Mt. Santa Rosa falls and rapid advance is made to within one mile of north coast. 9 AUGUST - Troops advance to coast, sweep Japs from Point Ritidian. 10 AUGUST - Small pocket of Japs confined to Pati Point. Organized Jap resistance ends at noon on 10 AUGUST 1944.

3RD MARINE DIVISION.

21 JULY - Lands at Asan against light opposition. 22 JULY - Northern beachhead expanded following fierce Jap attacks at Adelup Point. 25 JULY - Takes Cabras Island, Piti Town and trail leading to Mt. Tenjo. 25 JULY - U.S. Forces join to control 12 miles of coast.

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Guam, largest of the Marianas Islands, is situated 1572 miles from Tokyo. The island, about 32 miles long and 4 to 10 miles wide, has an area of approximately 225 square miles, or about three times that of Saipan. Due to its size, good harbor, and strategic location, Guam became the most important single island on the road to Japan, and ultimate victory over the Japanese. Headquarters for Fleet and B-29 operations in the Pacific, it had three large Superfort bases and numberous Naval Air Fields.

The battle for Guam, though not the toughest in the Pacific, was one of the most important waged by United States Soldiers and Marines. Some of the Unit commanders were Rear Admiral Richard L. Connelly, Commander of Amphibious Operations---Major General Roy S. Geiger, Commander Third Amphibious Corps---Major General H. A. Turnage, Third Marine Division---Brig. General Lemuel P. Shepherd, First Provisional Marine Brigade---and the famed 77th Army Division, under the able direction of Major General A. D. Bruce.

D-Day for Guam was 21st July 1944 when troops of the 77th Infantry Division landed at Agat, while Marine forces went in at Asan. The assault followed 17 days of furious air pounding, in which Guam had been softened by 10,000 tons of shells from Naval guns.

Like troops of the 27th (who went into Saipan and then Tinian) the 77th got their welcome from mortars and machine guns. Guam was a rolling, jungled island, with volcanic hills and peaks which provided good defensive terrain. On such high ground at Mt. Barrigada, the Japs were dug in strongly; but Guam's main town, Agana, was reduced to rubble by shellfire in the first days of the campaign.

After landings on either side of Port Apra, the 77th cut off the Orote Peninsula in the west, then drove to the eastern coast. The push up the island took over two weeks; when it was over, and the remaining Japs were driven into the hills, more than 14,000 enemy dead had been counted.

It was not a battle of sizeable opposing forces. However, for men of the 77th, Guam will be remembered as a contest of wits and fighting skill. The island was declared secured on the 10th of August 1944.

The 73rd Wing, was the first of the five wings of the XXI Bomber Command which were ultimately scheduled to go into combat. On the 10th of August 1944, the first service group arrived at Saipan to start preparations of the necessary facilities of the 73rd Wing Base. The first B-29 of the Wing arrived at Isley Field, Saipan, on 12 October 1944.



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From the arrival of the first units, all efforts were bent toward getting the mighty Superforts over Japan as quickly as possible. Problems of inadequate airfields and housing facilities, maintenance equipment and limited supplies, had to be overcome before the first mission could be conducted. The fact that the entire wing, including four bomb groups, were stationed together at one airfield created unique problems of organization and administration. Never before in Army Air Force History had a total of more than 12,000 personnel been located at one combat base.

In a directive from Headquarters, Twentieth Air Force, Washington, D. C., the XXI Bomber Command was given the primary task of destroying the Japanese aircraft industry and a secondary task of supporting Pacific operations. In accordance with this directive, the first mission to the Empire occurred on 24 November 1944, when 111 aircraft were airborne against the Nakajima Aircraft Company plant at Musashino near Tokyo. Attacking from 30,000 feet, only 24 aircraft bombed the primary target, which was partially obscured by cloud cover while 59 dropped their bombs on the secondary target, the urban area of Tokyo. This attack marked the opening of an air operation unparalleled in military history.

The operations of the Marianas-based B-29's can be divided into two distinct phases:

1. 24 November 1944 to 9 March 1945---This phase can be termed a period of tactical experimentation and adjustment during which the command sought to determine the operational capabilities of the B-29 in the air offensive against Japan, and the best method of utilizing these capabilities in light of the knowledge to be gained of the enemy's vulnerability and defense tactics.

2. 9 March 1945 to 15 August 1945---During this phase the effort of the command was devoted to the application of the tactical knowledge and experience previously acquired. This phase was marked by the beginning of low altitude incendiary attacks and was characterized by intensive operations designed to maximize the effects of B-29 attacks on the enemy's economy.

Phase I

The attack on 24th November 1944, set the pattern for the strikes which followed, prior to the 9th of March, 16 were against priority targets in the aircraft industry group, particularly aircraft engine plants; four were against the urban areas of Tokyo, Nagoya and Kobe. In addition, two strikes were against Iwo Jima in December to assist in neutralizing the enemy defenses.





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With the exception of a small harassing night attack against Tokyo the planning during the period, was substantially the same for all the attacks against the mainland. The B-29's were to take off in the early daylight hours from their bases in the Marianas, assemble in squadron formations, usually at Nishino-Shima and bomb at 30,000 feet, later reduced to 27,000 feet. For the most part only high explosives bomb loads were carried, usually 500 pounds general purpose, although incendiaries were carried on the raids against the urban areas, and both types were dropped on several precision targets.

The chief factor preventing this plan from being executed successfully was the weather. Severe weather fronts enroute to the target made navigation difficult, particularly since Loran and other navigational aids were not yet operating. Formations became scattered and the slender fuel reserve often forced aircraft to bomb targets of opportunity on the coast rather than penetrate further inland to the primary target.

Moreover, once over the Empire, the weather was often not as predicted. Weather forcasting was extremely difficult with little or inadequate weather service from the important areas west and northwest of Japan. The very high bombing altitude added to the weather difficulties because of the accompanying strong winds, and the fact that it was possible for any one of several cloud layers to obscure the target. The experience with the weather is indicated by the fact that of the 16 attacks during the period against priority targets, 4 completely failed to bomb the primary target while only 7 bombed with three-fourths of the airborne force, and 5 with less than three-fourths of the force.

Until 4th February 1945, the operations were conducted by the 73rd Wing with an average of 125 B-29's assigned. On 4th February 1945, the 313th Wing joined with the 73rd and on February 5th, two groups of the 313th Wing went into combat. The aircraft strength of the command increased from 119 aircraft on 24th November 1944 to 385 on 9 March 1945. During the entire period, each Wing operated with inadequate airfield facilities, maintenance equipment, and supplies, and limited target information. During the three months of December, January, and February missions were conducted on only 18 of the 90 days or one every five days. All of these factors combined to produce a high non-effective rate of airborne aircraft, and a low rate of combat effort (3 to 4 sorties monthly, per assigned aircraft, and an average of 58 hours per aircraft and 44 hours per crew were flown).

Phase 2

Against the background of operations described in Phase 1, the 20th Air Force, decided to conduct night low altitude incendiary attacks against the urban industrial concentrations of Japan's principal cities.

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Several considerations led to this decision. From the viewpoint of target selection, Japan's industrial system, including, as it did a large number of small workshops, scattered throughout urban areas, was particularly vulnerable to incendiary attacks against these areas. In addition it was hoped that the high intensity fires started by the various incendiary bombs would spread to the priority targets located within the large cities. However, these factors by themselves were not sufficient to cause the change. Rather, the most important consideration was the fact that this change made possible a concurrent change in the flight plan. Urban area attacks, do not require the same degree of bombing accuracy as precision targets. Therefore, it was felt that the desired destruction could be accomplished by radar bombing methods even when cloud conditions completely obscured the target. Thus the weather obstacles could be overcome.

It was further decided to attack by night with individual aircraft bombing at altitudes ranging from 5000 to 8000 feet. The chief advantages offered by this method were the following:

1. Greatly increased bomb load, resulting from elimination of formation flying and climbing to very high bombing altitudes.

2. Greater effectiveness by reducing losses and aborts caused by the strain on engines and other parts of the aircraft at very high altitudes.

Although the low altitude involved the risk of heavier anti-aircraft fire, it was felt that the advantages of surprise and the weak enemy night fighter strength would outweigh this disadvantage.

Under this plan, five night attacks against major Japanese cities were launched within ten days, commencing with the attack of 9th March thru 19th March against Tokyo. In this ten day period three wings, one of which, the 314th, was just beginning combat operations, dispatched 1,595 B-29 sorties against Japan, dropping 9,365 tons of bombs from altitudes averaging 7,000 feet on four major urban areas, and destroying 32 square miles of densely populated and highly industrialized areas. The cost of 14 aircraft for the missions over Tokyo, and 8 aircraft for the other four missions (a total of 1.4% of the sorties) was not considered excessive.

In general, the operations of the command fell into the following categories:

1. Urban Industrial areas
2. Priority targets
3. Mining
4. Tactical support
5. Atomic Bomb

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These categories of operation, cannot be separated chronologically since two or more types were conducted each month, sometime even on the same day. All the operations during the period were effected by a number of important factors which require further explanation.

First, the size of the command was continually increasing. The 314th Wing participated in its first combat mission on 9th March 1945. Meanwhile the decision had been made to transfer the 58th Wing from its India bases to West Field, Tinian. An advance echelon of 16 aircraft and crews began arriving at Tinian on 21 March and were attached to the 313th Wing until the remainder of the Wing began arriving on 21 April. The aircraft of the 315th Wing began arriving in the theater on 27 May 1945 and they participated in their first mission on 26 June 1945.

Next, the existense of Iwo Jima as an emergency landing base beginning at this time benefited the command in a number of ways. It provided a convenient assembly point, enroute to the Empire allowing aircraft to fly individually to this point for daylight strikes. Also it provided an emergency landing field for aircraft returning from the Empire. This reduced losses, and made possible further fuel savings. No longer was it necessary to plan such a high fuel reserve that all aircraft could return to the Marianas.

Iwo also provided a base for staging B-29 missions to Northern Honshu, Hokkaido, and Korea. It also provided a base for the fighters of the VII Fighter Command (later incorporated into the 20th Air Force) who furnished escort for a number of daylight strikes.

The devastating bombing attacks of the 20th Air Force were climaxed by the two missions on 6 August 1945 and 9 August 1945, in which the atomic bomb was released. On the basis of post strike photography, 4.7 square miles of Hiroshima (1st Atomic mission) and 1.4 square miles of Nagasaki (2nd Atomic mission) were destroyed and damaged. The additional devastation wrought by the atomic bomb marked a new era in modern warfare.

The primary mission of the 20th Air Force, in the Air offensive against Japan, was to achieve the earliest possible progressive destruction and dislocation of the Japanese Military, Industrial and Economic Systems, and to undermine the moral of the Japanese people to a point where their capacity for war was decisively weakened.

The secondary mission of the 20th Air Force was to operate in support of Pacific Operations to the extent and in the manner prescribed by the Joint Chief of Staff.



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180 square miles of industrial urban areas of Japan were burned out. The industrial productive capacity of 61 cities was destroyed and a population of 21 million Japanese people displaced.

602 major war factories were destroyed or severly damaged. This included aircraft factories, oil and fuel installations, arsenals, stell plants, and other industries. Not included, are the thousands of small feeder factories destroyed during incendiary attacks.

159,862 tons of bombs were dropped on Japanese targets. The Air Force averaged 1193 tons DAILY on Japan during the last three months of operation.

Over one mission tons of Japanese shipping were destroyed by Air Force Mines. The 20th Air Force flew 1782 sorties and dropped 12, 998 mines in this campaign which seriously curtailed Japanese water transportation and harbor facilities.

33,047 Bomber and 8,381 Fighter sorties were flown against Japan.

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REOCCUPATION OF GUAM

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The campaign in the southern Marianas was extended to Guam about the middle of July. Guam, of course, was a different story than Saipan or Tinian. The island, largest of the Marianas, had been an American possession until the Japs seized it after Pearl Harbor. Guamanians were Americans, and proud of it.

The terrain of Guam was rugged and mountainous, particularly so in the southern part, offering excellent cover and protection to the enemy in the numerous caves and brush areas. The island, about 32 miles long and 4-10 miles wide, has an area of approximately 225 square miles--about three times that of Saipan. Geologically Guam consists of two distinct and dissimilar parts. In the north it is a raised limestone plateau, covered almost wholly by dense low vegetation except where it has been cleared away for farming or for defense purposes. In the southern half there is a range of volcanic peaks towering at one point to about 1,300 feet. On the western shore it drops off abruptly into the sea with short and steep valleys running to the rocky shore. There are, however, many small sandy bays, divided by rocky points. The eastern shore, though bordered with steep cliffs and exposed to the ocean swells, slopes more gently, with larger valleys and big streams, none of which is navigable.

The population of Guam in 1939 was about 22,000 persons, less than 1,000 of whom were Americans, mostly naval personnel. The remaining inhabitants were largely native Chamorros, who have always maintained a friendly attitude toward the Americans. As the Japanese have held Guam only since its capture by them on December 10, 1941 (east longitude time), there has been no time for them to build up on the island a populace similar to that at Saipan, where the majority of the people were Japanese immigrants and consequently hostile to the conquering Americans.

Guam was the first American territory captured by the Japanese and when conquered in the campaign was the first sizable inhabited possession of the United States to be retaken from the enemy. The island's small garrison of sailors and Marines was overwhelmed by the Japanese two days after the attack on Pearl Harbor and the survivors, including five women nurses and a large number of American civilian construction workers, were taken prisoner.

Possession of Guam, little more than 1,500 miles from Tokyo and the Philippines, gave to the United States one of the best harbors in the western Pacific and, with Saipan and Tinian provided excellent facilities for air bases dominating large areas of the western Pacific. Occupation of the southern Marianas also increased the isolation of the Japanese bases in the western Carolines, bypassed and virtually neutralized by repeated bombings.

The campaign in the southern Marianas was extended to the island by United States assault troops who made landings on the 21st of July and on Tinian three days later. Both islands had been heavily bombed and shelled by our air and sea forces for many days in preparation for the invasion. The



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air and sea bombardment of Guam was one of the heaviest and most sustained ever conducted by our Fleet in the Pacific. Carrier-based planes hit the island with bombs and rocket projectiles for 17 consecutive days before the landings--627 tons of bombs and 147 rocket projectiles on the day before the assault. Surface craft, including battleships, shelled enemy positions on Guam daily for a week. Thousands of tons of shells were hurled on beach defenses, gun positions and other Japanese installations along the western coast of the island, particularly in the area between Agana, the capitol of Guam, and Orote Peninsula, site of the major airfield.

Simultaneous landings were made at two places on the west coast of Guam early in the morning of the 21st by assault troops of the Third Amphibious Corps. Elements of the Third Marine Division, veterans of the Bougainville invasion, went ashore in the vicinity of Asan, just east of Apra Harbor; First Provisional Marine Brigade, which includes such famous units as Carlson's Raiders, landed near Agat, south of Orote Peninsula and Apra Harbor. The assault waves proceeded with precision, permitting all attack units and their weapons, including tanks and artillery, to be landed as planned. Some mortarfire was received by the initial waves on the beaches at Agat prior to landing, but on the beaches to the north, between Asan and Adelup Point, mortar fire did not commence until after several waves had landed.

Good beachheads were secured at both assault points with very moderate casualties among the attacking troops. As our Marines moved inland, however, resistance stiffened, especially at the northern beachhead, which was subjected to heavy mortar fire throughout much of the day and night. Early in the morning of the 22d, the eastern sector of our northern beachhead was heavily attacked by the Japanese from prepared positions at Chonito cliff, which rises sharply from the beach between Adelup Point and Agana. For a short time the situation was critical, but the attack was broken up with the assistance of artillery, naval gunfire and air strikes.

On the right flank of the northern beachhead considerable progress was made early in the assault and by evening of the 23rd, the third day of the invasion, Piti town and all of Cabras Island had been occupied by the Marines. From Capras Island, which forms the upper arm inclosing Apra Harbor, our artillery could dominate the harbor and Orote Peninsula, which forms the southern boundary of Apra anchorage. Troops of the Third Marine also controlled the roads between Apra and Agana and one of the trails leading to Mt. Tenjo, the highest point in this part of Guam.

Japanese troops during the first night of the invasion of Guam also strongly attacked the beachhead at Agat, south of Orote. Here the First Provisional Marine Brigade, reinforced by elements of the Seventy-seventh Army Division repulsed the enemy attack, killing 268 Japanese and destroying 5 tanks. On the following day our troops expanded the beachhead in all directions, capturing Mt. Alifan and extending the flanks widely on both sides. Orote Peninsula and all the Japanese defending it had been cut off from the rest of the island by the 24th when our troops pressing north from Agat crossed the base of the peninsula and reached Apra Harbor. The gap



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between our two beachheads was closed on the 25th when our forces from Asan and Agat made contact on the east shore of the harbor, thus giving them control of about 12 miles of coastline. The American lines on the 25th extended from a point about midway between Bangi Point and Facpi Point, south of Apra Harbor, in a general northward direction across the base of Orote peninsula, along the eastern shore of Apra Harbor, then east as far as Adelup Point. The line was reported to have extended inland as much as three miles at some places, probably in the area east of Agat. The Japanese appeared to be strongly emplaced at the base of Orote Peninsula and in the sector between Adelup Point and Agana. Both of these areas and the enemy's rear had been subjected to continued heavy shelling by surface craft and frequent attacks by carrier planes.

Japanese strength on Guam was believed to be about the same as that of Saipan garrison, but the troops were reported to be of better caliber and supplied with new equipment. It was thought that a considerable part of Guam garrison was stationed in the Apra Harbor area and on Orote Peninsula: these were virtually isolated from the main enemy force around Agana and in other parts of the island's interior. The Japanese had already suffered heavy casualties but, as in the Saipan campaign, they resisted to the last man. In the first 5 days of fighting on Guam, Japanese dead numbered at least 2,400. Our casualties were light on the first day, but at Guam, as at Saipan, heavy resistence developed after the beachheads had been established and our troops started inland. Through the 25th our losses numbered 443 killed, 2,366 wounded and 209 missing.

The backbone of Japanese resistence on Guam's southwest coast was broken on the 26th when our invasion forces fought off two desperate early morning counter-attacks - one by the enemy troops trapped on Orote Peninsula, the other by the Japanese who had been stubbornly blocking extension of our left flank toward Agana. In severe fighting during the night of the 25th and the pre-dawn hours of the 26th, at least 2,400 Japanese were killed before our troops broke up the attack and drove the enemy back.

Troops of the First Provisional Marine Brigade, which had cut across the base of Orote Peninsula the previous week, trapping an estimated 2,500 Japanese, fought off the attack launched during the night of the 25th, killing about 400 Japanese and destroying 12 tanks. At dawn the following morning, American forces moved out on the Peninsula which was pounded hard by ship's guns, carrier planes and artillery. By nightfall they had gained nearly two miles and were in the outskirts of the Sumay naval base, on the northern shore of the peninsula compressing the remants of the enemy forces on Orote into the narrow limits of the tip of the peninsula.

On the following three days slow progress was made against the Japanese defending Orote from pillboxes and dugouts, but other units of the First Provisional Marine Brigade expanded their beachhead well into the interior and along the southern flank. In the center of our line, opposite Apra Harbor, our troops on the 28th smashed inland 2 miles to take several mountain peaks, including Mt. Tenjo, while to the south an advance of about a mile into the interior was made in the region east of Bangi Point. Having consolidated



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their lines, our Marines and Army troops on the 29th drove completely across Orote Peninsula, capturing the airfield and Sumay town and clearing the enemy from the entire peninsula. Capture of Orote gave us unopposed control of Apra Harbor and an excellent airfield site.

Meanwhile, Marines of the Third Division on the left flank of the beachhead east of Adelup Point were attacked before dawn on the 26th by an estimated 6,000 Japanese. The attack was probably launched from the blackened ruins of Agana, against which the Marines had been exerting pressure for several days. Large numbers of the enemy infiltrated our lines and at one point a few of them penetrated to within 100 yards of the landing beach. These were soon liquidated. The front line was strongly engaged but was never broken, and after dawn the attack was repulsed, with the aid of planes. The number of Japanese killed in the fighting at this point was not less than 2,000.

Slow progress was made in the Adelup Point sector, facing Agana, following the enemy counterattack of the 26th, but by the 28th the Japanese had been driven from their strong positions just east of the capital and our troops were within half a mile of the town. Little change in the situation occurred until the 31st, though our patrols were active beyond the lines, probing the enemy's defenses east of our forward positions halfway across the island east of Apra Harbor. On the 29th and again on the 30th our patrols crossed to the east coast without meeting the enemy. On the 31st, American troops drove forward to capture Agana and reach the east coast on a wide front below Pago Point, this cutting the island in two. Patrols were active in the southern part of the island and reported finding only stragglers and small scattered groups of Japanese. The remaining Japanese had apparently withdrawn into the northern section of Guam, although the mountainous terrain of the south would seem to lend itself better to last-ditch fighting than the rolling plateau country of the north. A large force of Japanese was reported in the vicinity of Mt. Santa Rosa, on the east coast approximately 5 miles southwest of Pati Point. The enemy troops in this area, which on the 1st was bombed and shelled by naval planes and ships, was said to be badly demoralized.

Our lines at 1800 on the 1st extended from the beach about a mile east of Agana to the eastern edge of Pago Bay, on the east coast. Our troops were nearing the western edge of Agana airfield. Mopping up operations were in progress in the southern part of the island and were completed on Orote Peninsula.

Japanese casualties continued to mount. By August 1st, 6,775 enemy dead had been counted, while only 48 prisoners had been taken. Considerable enemy equipment had been destroyed or captured, including 34 tanks, 37 75-mm guns, 20 5-or 6-inch guns, 15 8-inch guns and many motor vehicles. Our troops also captured 50,000 gallons of gasoline, which was used by American forces.

United States soveriegnty was reestablished on Guam on July 27th through a proclamation by Admiral Chester W. Nimitz, read by Gen. Geiger's Chief of Staff at a flag raising ceremony. The American flag was hoisted to the top of a white metal pole in the shadow of Mt. Alifan, formally proclaiming the end of more than two and a half years' occupancy by the Japanese.



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After capturing Agana, Guam's capitol, our forces commenced a concerted advance that on the 2nd swept over Tiyan airfield, east of Agana, and a number of small villages. Enemy resistance stiffened at times, being particularly strong along roads and trails, where hastily constructed defense positions were set up. A brief delay in our advance was encountered in the vicinity of Mt. Barrigada, a 674-foot peak which dominates the eastern coast of Guam, but opposition was soon overcome and troops of the 77th Army Division continued their sweep up the east coast. Meanwhile, Marines of the Third Division captured the inland village of Finegayan, a junction for several roads leading north. Yigo, just southwest of Mt. Santa Rosa, was captured on the 7th; large stocks of ammunition, transport equipment and other supplies were taken. Our troops in capturing Yigo, stormed and overwhelmed very strong defenses protecting the approaches to Mt. Santa Rosa, where the Japanese had apparently concentrated most of their troops. This area was repeatedly attacked throughout the week by our carrier planes. On the 8th, by a rapid advance in the center, which carried our troops within a mile of the coast, the Japanese forces were almost cut into two groups - one in the vicinity of Ritidian Point and the other at Pati Point. In the day's forward push, Mt. Santa Rosa was captured; with its loss the Japanese were deprived of their main source of water. On the following day, enemy forces were swept from Ritidan Point, and all the survivors of Guam's Japanese garrison were surrounded in a small pocket in the Pati Point region.

The Japanese apparently effected a complete withdrawal of forces from the southern part of Guam before our forces cut the island in two, for patrols combing the mountains in the south report finding no enemy troops.

All ground operations received daily support from our carrier aircraft, which attacked with bombs, rocket projectiles and machine gun fire on enemy positions, troop concentrations, stores and motor transport in areas behind the lines.

The total of counted enemy dead on the 8th reached 10,000. In territory occupied by United States troops in the vicinity of Yigo however, a large cemetery was found with evidences of recent mass burial of Japanese dead, indicating the total was much higher than could be determined by count of bodies left on the battle field. A Pacific Fleet communique on the 3rd revealed that United States casualties through August 1st totaled 6,273 -- 1,022 dead, 4,946 wounded and 305 missing.

Most of the civil population was apparently now safe inside our lines. On the 5th, Admiral Nimitz reported that approximately 22,000 civilians had found refuge within American-controlled territory. Only a small number of natives remained in the northern area still held by the Japanese, for the 1940 census of Guam's population listed a total of 23,067 inhabitants.

Organized resitance ended just before midday on the 19th after American forces overwhelmed the Japanese force holding out in a small pocket at the northeastern tip of the island. At the end, many of the Japanese fled into caves or into the brush instead of dying in suicidal attacks, as they did on Saipan. Brig. Gen. Lemuel C. Shepard, commander of the First Provisional Marine Brigade, was quoted as saying that the Japanese have been known to





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withdraw from positions for tactical reasons but "never to run for their lives like these enemy stragglers on Guam". Mopping up operations to eliminate snipers, stragglers and small resistance. While searching out enemy troops, our forces found in one cave on the northeastern coast about 300-400 dead Japanese.

In the three-week campaign, American Marines and Army troops suffered 7,247 casualties - 1,214 killed, 5,704 wounded and 329 missing. A total of 10,971 Japanese dead were counted by our troops through the evening of the 9th, the day before resistence ceased. In that time our troops captured 86 prisoners and interned 7 Japanese civilians.

The reoccupation of Guam was not a battle of sizeable opposing forces, but a contest of wits and fighting skill. usually in the dark. The Japs had favored night infiltration tactics in all their Pacific campaigns, but on Guam they exploited them to the full.

By day men fought a war of mud, guns and tanks; by night a war of nerves, when each rustle, each dull snap of a twig, was a danger signal.

You dozed, fingering your rifle, alert for the slightest sound that was unfamiliar and hostile. If you were alone, the tension was magnified. The whole world of living, friendly guys were somewhere beyond reach. You were one guy alone in a little foxhole of goosy mud.

The heavy air, damp with the smell of ferns and earth, tempted you to fall asleep. You didn't. One eye always open, ready for the sudden thumping drop of a silent enemy who might lunge without warning.

If he came, the struggle was savage and short. You slugged him with a rifle butt, you kicked him in the groin as soon as your eyes distinguished him in the darkness. He grunted or he screamed. You tried to throttle him; if you could use your rifle in a hurry, you shot him.

In the morning you found yourself next to a corpse whose face always looked blank and mask-like in death. A stunted, stiff little man, with or without eye-glasses, whose fighting ability wasn't as good as his stealth.

That was Guam - a succession of muted encounters in the night, a series of abortive battles by day. Soldiers of the Battle of Guam have an electrifying memory of struggles in the dark, sleepless nights when they squirmed in rainfilled foxholes on the lookout for a creeping enemy.

When organized resistence ended on Guam, we could take stock of our achievements in the most viciously fought campaign of the Pacific war. Our victory had its reverberations in Japan, we knew why the entire Tojo cabinet resigned after Saipan and Guam were lost.

Exploiting Guam to the full was the next step. The airfields had to be rushed through, so thousands of service troops poured in from the Hawaiian Islands.



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Guam became a massive naval base, advance headquarters of the Pacific Fleet. On Harmon Field the Liberators and Superforts roared in past big C-54 transport planes of the Air Transport Command. Guam, like Saipan, was the air gateway to the Philippines and the Orient.

To the men who arrived in the wake of battle, this rapid development was part of a job. To those who fought for the Marianas and then moved on to new battlefields, it was the work that gave meaning to their victory.

The service and garrison troops knew the part they played. The miles or war materials lining the roads, the acres of trucks, the warehouses crammed with food, clothing, supplies, were the key to success on other islands - Iwo, Anguar, Peleliu, Leyte and finally Okinawa.

Through the Marianas passed the fresh troops who would fight these battles and through the Marianas came the wounded in hospital ships and transport planes.

Guam was 3,340 miles from Oahu, but only 1,267 miles from Tokyo. The most daring amphibious blow of the war had paid-off.

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CIVIL SITUATION ON GUAM

1. Guam was discovered by the Spanish explorer Magellan on 6 March 1521. He initially named the group the Islands of the Lateen Sails, but changed it to Los Ladrones. Later the Jesuits renamed the islands the Marianas in honor of Queen Maria Ana, widow of Philip IV of Spain.

2. Original estimates by the Spanish put the population of Guam at fifth thousand (50,000) but later explorers put the figure at nearer thirty thousand (30,000). The other islands had corresponding figures. These people were organized in clans under a chief called "Chamorri".

3. Continual and savage fighting with armored and armed Spanish forces destroyed thousands of the natives until by 1698 there were only about sixteen hundred (1600) natives left, all on Guam with none of them on the remaining islands.

4. Although the original Chamorros were exterminated by the Spanish (only two were still alive in 1824) the population of the island gradually increased as members of the Spanish garrison remained on Guam and multiplied; the yearly galleons from Acapulco in Mexico brought Mexican Indians to Guam and on the return trip from Manila brought Filipinos who remained on the island. In the years, Carolinians, Japanese, Chinese, and since 1900, Americans have combined to produce the present racial group who are known as Chamorros but who are really a distinctive racial group more properly known as Guamanians.

5. The present inhabitants of Rota and Saipan while racially affiliated with the Guamanians present considerably different characteristics becuase of the preponderance of Carolinian, Japanese, and German people in those islands. The basic similarity is indicated by the family relationships between the inhabitants of Guam, Rota, and Saipan. The few chamorros living on the northern islands of the Marianas group were brought to Saipan in 1945 and the northern islands are uninhabited at the present time.

6. Chichi Jima in the Bonin Islands was first settled in 1815 by colonies from the United States and Great Britain accompanied by a few Hawaiians. Around 1875 Japanese began to come in from the empire. They settled on Chichi Jima and other islands of the group until by 1914, the original colonists were outnumbered and the Bonins became Japanese islands. The original English and American colonists persisted and today form an interesting and unique settlement.

7. Before the war there was approximately twelve hundred (1200) Japanese on Iwo Jima, about nineteen hundred (1900) on Haha Jima and about forth-three hundred (4300) on Chichi Jima and its satellite islets.



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8. During the war the civilian population on all the islands suffered. During 1943 all civilians on Iwo Jima were evacuated to Japan, and those on the other islands were killed or were cleared out after the war by the Occupation Forces; many were killed on Saipan, Tinian and Guam during the reoccupation of these islands.

9. The latest report of the population shows the following approximate figures:

| | | |
|---|---|---|
| Guam | 24,000 | |
| Rota | 376 | |
| Saipan | 4,696 | (about 1/3 Kanakas) |
| Tinian | 12 | |
| Chichi Jima | 134 | |

10. Living is difficult for most of the inhabitants except on Guam. There, the demand for workers exceeds the supply, and the pay scale is high compared with pre-war scales. This has resulted in a large amount of money the island. For February, 1947, the Gross imports not including PX and Commissary supplies, were $654,516.00. A number of firms are operating in retailing and wholesaling, besides farming; poultry raising, swine, fishing, the manufacture of soap, ice and soft drinks, and the service industries, such as restaurants, etc.

11. On Saipan there were one hundred and twenty-eight (128) firms or individuals doing business in March 1947, with a gross of $23,555.00. These included among others, silversmiths, seamstresses, blacksmiths and fishing.

12. The inhabitant on the Marianas does not make the fisherman that the Bonin islander does. Too many years of people working along agricultural lines have weaned him from the sea. However, the one hundred and thirty-four (134) people of Chichi Jima are seamen first, and the fishing industry is expected to do well there. It is now in the formative stage, and the people are still receiving some subsistence supplied from the Military Government. It is expected they will be self-supporting by the end of the year.

13. The Guamanians form a unique group in their universal adherence to the United States. Passively, but thoroughly loyal to American government before the war, they were intensely and actively and actively pro-United States during the Japanese occupation - so much so that many were butchered and more were subjected to physical torture and gross indignities for their wanton display of American sympathies and loyalty. They emerged



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from the war almost fanatic in their active demands for full American recognition, including United States citizenship, admission as an element in the American Commonwealth and supression of any implication that they were not American in every detail.

14. On Saipan and Chichi Jima the people are friendly to the United States and no subversive activity has been reported.

15. The stateside population of Civil Service workers and contractor employees present the most potent source of subversive activity. Recruited without investigation, the contractor employees in particular - Caucasion and Filipino - include an unusual large proportion of men with criminal records and unsavory backgrounds. It has been necessary to double a large police force to cope with the problems presented by this imported population. Approximately 80% of the arrests are transcient population - largely contractor employees. They are being registered, fingerprinted and classified as rapidly as they can be identified and FBI reports received.

16. It is estimated that less than thirty (30) renegade Japanese remain on the island. They are not aggressive. A Scouting Patrol of thirty (30) men of the Guam Police maintain a continuous search for these fugitives with occasional success - since December 1946, six or eight have been located and killed.

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# The BATTLE for SAIPAN

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Saipan, the first of the Marianas Islands to be taken, was the initial test of the enemy's strength on its inner defense ring. This island, the second largest in the Marianas, was the first Jap held territory taken by U.S. Forces which would put the B-29s within operational range of Tokyo, Nagoya and other crowded Japanese cities. The first B-29 attack, which was launched from Saipan, was the opening of a new phase in the air war against Japan -- a phase which was later to bring the enemy to his knees in defeat.

The 25-day campaign for Saipan was not an easy one. It was marked by fierce last-ditch stands and some of the most desperate, suicidal counterattacks then experienced in Pacific battles. Even after the battle was won, many Japanese soldiers and civilians perished by hurling themselves from the cliffs at Marpi Point. It was estimated that the Japanese lost approximately 95 percent of the 20,000 to 30,000 troops defending the island. Their aircraft losses outnumbered ours by a ratio of about 5 to 1.

Units participating in the campaign for Saipan were:

Second Marine Division
Veterans of Tarawa

Fourth Marine Division
Veterans of the Marshall Islands Campaign

Twenty-Seventh Army Division
Veterans of the Gilbert Islands Campaign

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# The BATTLE for SAIPAN

11 June 1945 - Beginning of intensive air and naval bombardment of Saipan. 13-14 June 1945 - Minesweeping and reconnaissance of landing beaches by Underwater Demolition Teams carried out. 15 June 1945 - D Day - 2nd and 4th Marine Divisions land at CHARAN-KANOA at 0840. Landing opposition light, but stiff resistance develops. 16 June 1945 - 27th Infantry Division (Army) lands on southern part of beachhead. Japs retake part of beachhead in northern sector. 18 June 1945 - Stubborn Japanese resistance broken as troops reach MAGICIENNE BAY and capture ASLITO (ISLEY) Airfield. Entire southern portion of island, excepting NAFUTAN POINT, in U. S. hands. 20 June 1945 - Progress is slow along MAGICIENNE BAY. Reinforcements land. Part of 27th Division pushes Japs into NAFUTAN POINT; remainder of force forms for attack to north. Much enemy artillery destroyed. Spotting planes begin operation from CHARAN-KANOA strip. 22 June 1945 - Army P-47s begin operating from ISLEY Airfield. 23 June 1945 - Troops reach slopes of MT. TAPOTCHAU and take most of LAULAU town. 25 June 1945 - Second Marine Division enters GARAPAN and captures MT. TAPOTCHAU while 4th Division takes most of KAGMAN PENINSULA. Twenty-seventh Division advances in center. 28 June 1945 - Jap resistance stiffens at GARAPAN but 4th Division advances on Eastern shore. Pocket at NAFUTAN POINT eliminated. 2 July 1945 - Advance becomes more rapid with deep penetrations in center of island toward TANAPAG. 3 July 1945 - GARAPAN falls. 4 July 1945 - Most of TANAPAG falls as demoralized enemy begins withdrawal toward northern end of island. Second Division withdrawn as reserves; 27th Division takes over left flank. 7 July 1945 - Japanese launch fierce "Banzai" counterattack on 27th Division sector. Enemy penetrates 2000 yards with heavy casualties on both sides. Ground retaken by dark. 8 July - Attack resumed with 2nd Division replacing the 27th Division on the left. Rapid advances during the day. 9 July - Rapid advances made until 1545 when all organized resistance ends. Vigorous mopping up operations to clear Japanese from caves and hills continue for many days.

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# SAIPAN

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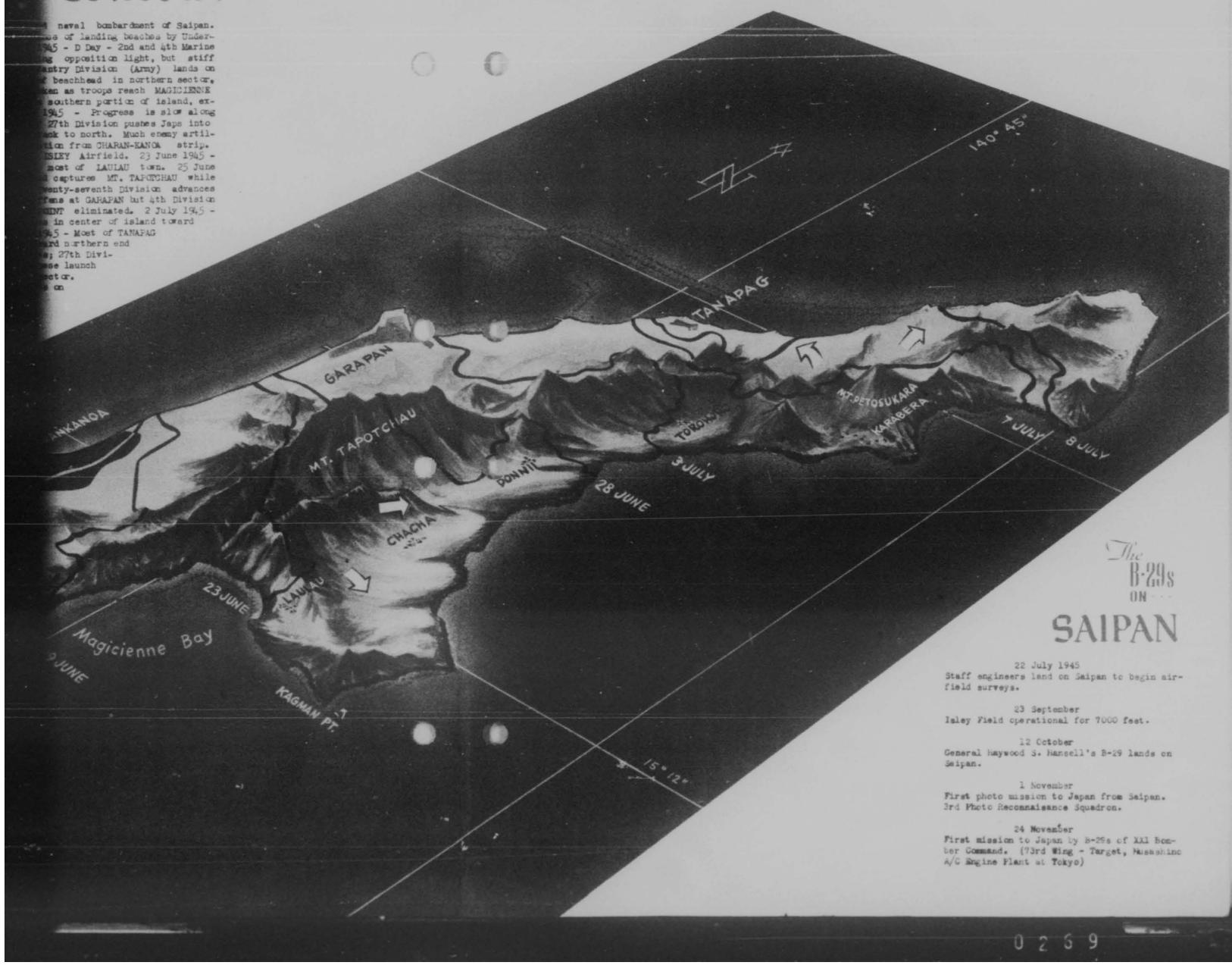


## The B-29s on SAIPAN

22 July 1945
Staff engineers land on Saipan to begin airfield surveys.

23 September
Isley Field operational for 7000 feet.

12 October
General Haywood S. Hansell's B-29 lands on Saipan.

1 November
First photo mission to Japan from Saipan. 3rd Photo Reconnaissance Squadron.

24 November
First mission to Japan by B-29s of XXI Bomber Command. (73rd Wing - Target, Musashino A/C Engine Plant at Tokyo)

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Saipan is located at Lat. 15°05' N., Long 145°45' E about two and three-fourth miles NE of Tinian and 136 miles NE of Guam.

Saipan is the second largest island in the Marianas and was the first Jap held territory to be taken by U. S. Forces.

Saipan has a backbone of mountains running from North to South. Mt. Marpi, Mt. Petesukara, Mt. Atchugau, Mt. Tapotchau and Mt. Fina Susu are the highest points of land. The western portion is rolling, fertile and excellent for farming. The eastern portion has steep cliffs, rugged hills and deep ravines. Most of the people and the cities are on the western side. Between Kagman Point and Mt. Tapotchau is a large area of level fertile land that was formerly used for farming. Many of the slopes have been cleared and used for agriculture but a considerable portion of the upland is forrested.

Saipan enjoys a warm, damp climate with hot weather and much rainfall. The months from June to October are the warmest while January, February and March are the coolest. The average rainfall is 85 inches. Most of the winds blow from the east, northeast and southeast. The days with the most daylight are in June, July and August when the sun is almost overhead. The longest days have about 13 to 13½ hours of daylight while the shortest have from 11 to 11½ hours.

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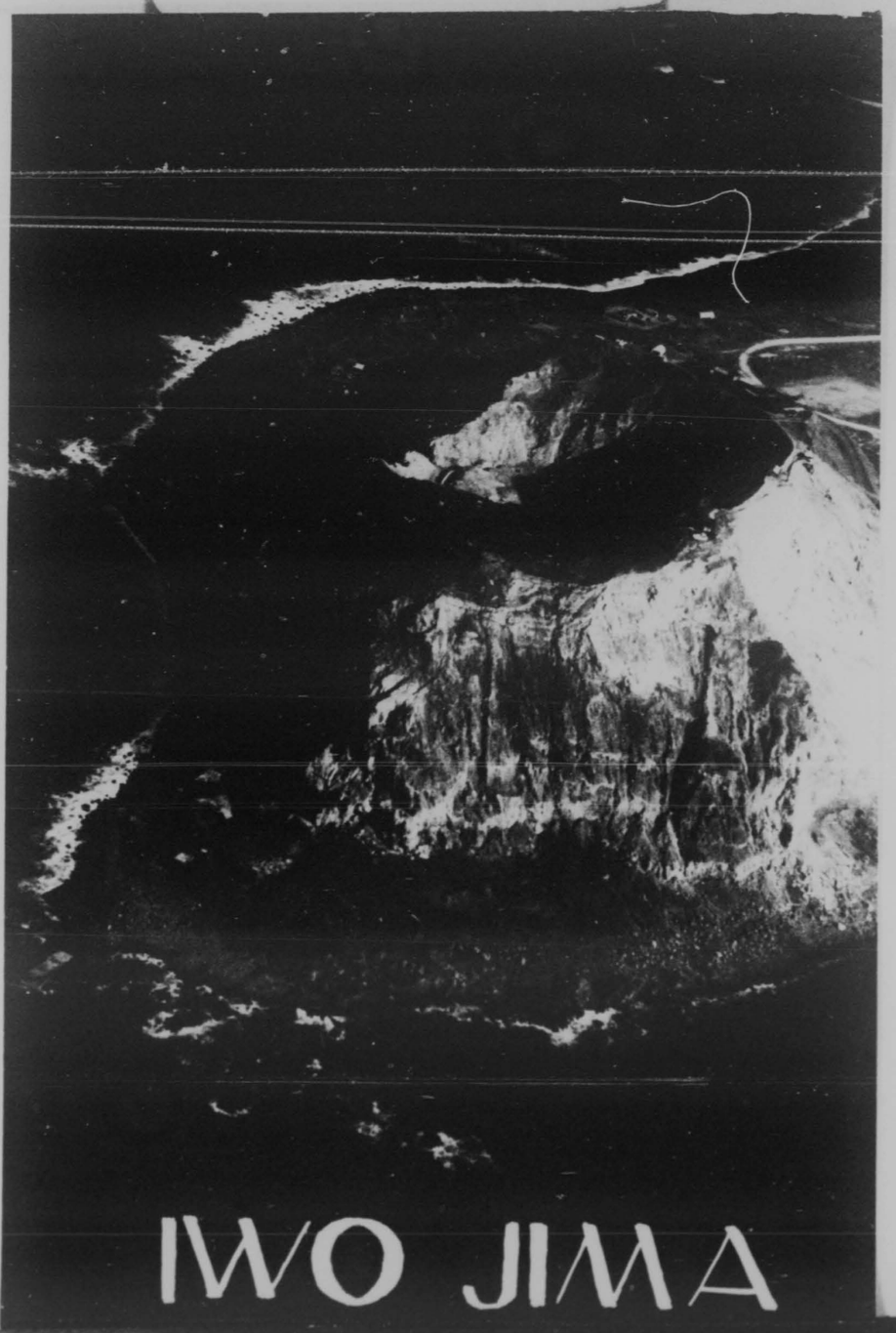


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# The BATTLE for IWO JIMA

The twenty-six day campaign for Iwo Jima which required three divisions was the toughest and most costly battle in Marine history. This 3 x 5 mile bastion in the Pacific with its complete network of pillboxes and underground installations was the true key to the inner circle of the Japanese homeland defense, and the Jap resistance there was the epitome of fanatical, last-ditch stands.

However great the cost, the taking of Iwo Jima paid tremendous dividends in saving B-29s and improving Twentieth Air Force operations. All agencies of the Twentieth benefited by the Iwo campaign. However, the greatest measurable saving was in the number of Superforts which made emergency landings there during the war; that total was 2396 -- or 9.2% of all B-29 sorties. Many of these landings were for minor repairs or for gasoline, but a great percentage of those aircraft would never have completed the 3000 mile missions had it not been for this half-way station 627 miles from Saipan.

Iwo helped immeasurably in many other operational fields. It was a base for the P-51s which could then accompany the B-29 to Japan or stage their own attacks on the Bonin Islands or the Japanese Air Force. Iwo removed many navigational headaches through a vastly extended range in our communications facilities. It helped fill in the weather data gaps, aided the air sea rescue unit and photo reconnaissance aircraft, and toward the end of the war, made possible B-29 strikes to the northern extremes of the Japanese home islands.

The price for this speck in the Pacific was tremendous but its possession by U. S. forces was of primary importance in shortening the war and making possible the crushing defeat delt the Japanese by air power.

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# The BATTLE fo

D-DAY 19 FEBRUARY - Three Marine divisions (3rd, 4th and 5th) land with little opposition, crossing the island and taking the southern end of Air Field No. 1. By 1800 the 5th Division almost reached Mt. Suribachi. The 4th Division casualties ran high on the open slopes of the airfield.

D PLUS 1 - Jap counterattack on 5th Division repulsed; 28th Regiment swings to southwest to attack Mt. Suribachi.

D PLUS 2 - Jap counterattack repulsed by 27th Regiment. The 28th Regiment attacks Suribachi against strong resistance and reached the base at 1500 hours. Over 800 support missions flown by carrier planes.

D PLUS 3 - Slow progress by 28th Regiment on Suribachi. Five ships hit by attacking force of 50 Jap planes. By 1400 hours the base of the crater on Suribachi is encircled.

D PLUS 4 - The 4th and 5th Divisions begin attack to the North, are held up by heavy mortar and artillery fire. A 28th combat team reaches the rim of Suribachi's crater.

D PLUS 5 - Attack resumed at 0930 preceded by 45 minute artillery barrage. Small gains made. Most of #2 Airfield taken.

D PLUS 7 - The 3rd Division gains 400 yards and seizes ground north of #2 Airfield. U.S. aircraft begin operations from 1500 feet cleared on #1 Airfield.

D PLUS 8 - The 3rd and 5th Divisions advance about 200 yards against stiff opposition following artillery preparation.

D PLUS 9 - Southern end of island secured.

D PLUS 10 - The 3rd and 5th Divisions advance rapidly against lighter opposition. Elements cross #3 Airfield.

D PLUS 11 - A total of 15 battalions press the attack. The 3rd Division advanced about 700 yards North of #3 Airfield.

D PLUS 12 - Slow progress made by all divisions due to heavy mortar and artillery fire; make gains of 200 to 400 yds.

D PLUS 13 - Sixteen battalions in the assault. The 4th Division eliminates pockets around Minami. Hand to hand fighting in some areas. A B-29 returning from Japan lands, refuels and immediately departs for its home base.

D PLUS 14 - Consolidation of gai
mopping up operations in the rear areas.

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D PLUS 16 - The 3rd Division adva
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D PLUS 18 - Generally quiet night.
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D PLUS 19 - Slow progress is made
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D PLUS 20 - Little change in battle
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D PLUS 14 - Consolidation of gains with mopping up operations in the rear areas.

D PLUS 15 - Attack begun at 0800 hours following tremendous naval and artillery barrage in preparation. The 3rd Division advances 400 yards. Slow progress in other areas. 28 P-51s of 7th Fighter Command land at noon.

D PLUS 16 - The 3rd Division advances 500 yards in hand to hand fighting. The 4th advances 200 yards. P-51s take over local RVP.

D PLUS 17 - Slow but steady progress made against desperate and stubborn enemy.

D PLUS 18 - Generally quiet night. Progress made during day although resistence stiffens. Marine attacks supported by naval guns and P-51s.

D PLUS 19 - Slow progress is made against snipers and fire from caves, pillboxes and block houses. Troops reach beach at center of line.

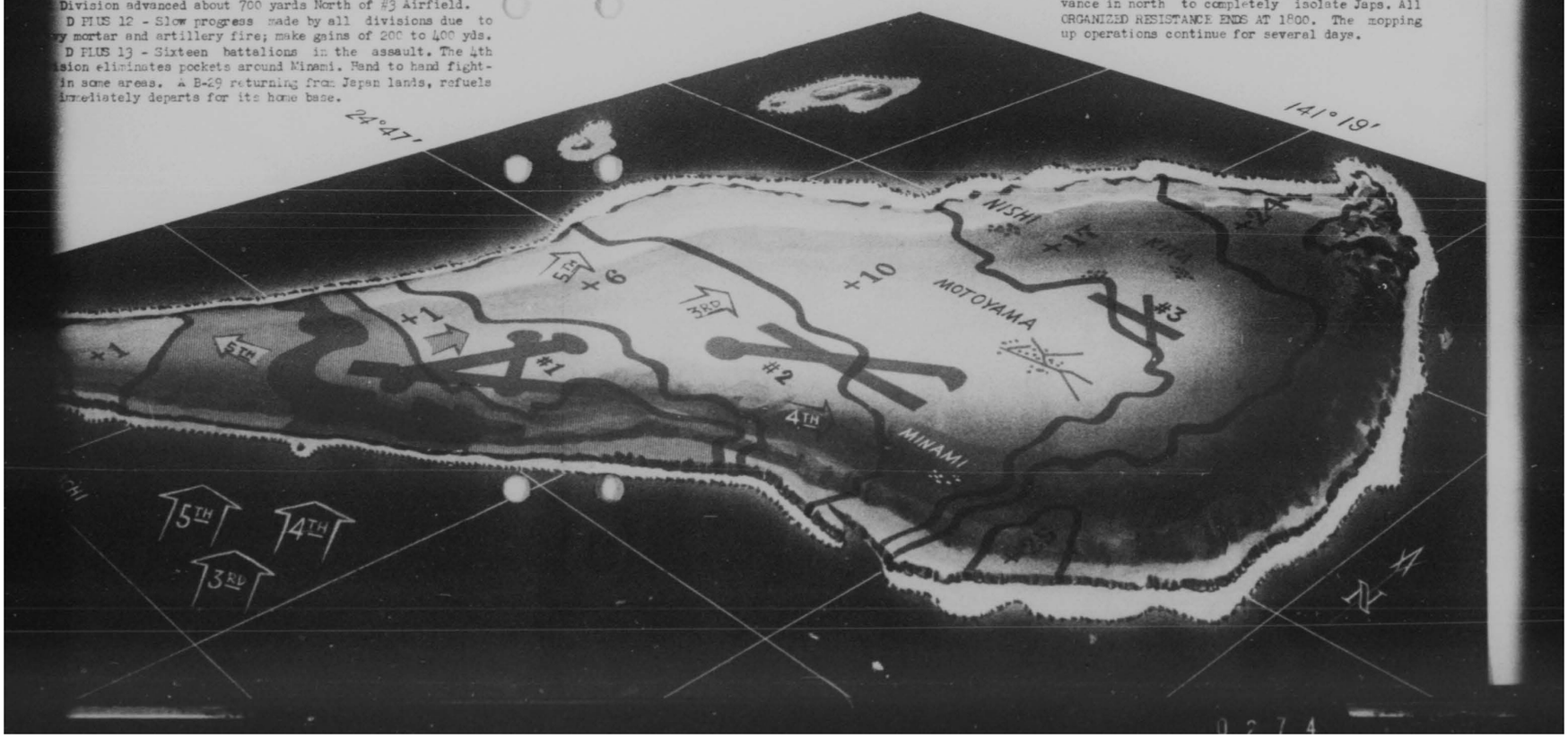
D PLUS 20 - Little change in battle lines. The 3rd Division secures about 1000 yards along beach due east of #3 Airfield. By 1800 organized resistance is practically over in the 3rd and 5th Division sectors except for isolated pocket of 300 Japs. A thousand Japs remain in the 5th Division sector. P-51s fly support there.

D PLUS 21 - The 5th Division supported by naval fire and P-51s advance 75-100 yards along front while 3rd and 5th continue to mop up.

D PLUS 23 - Northern sector continues to resist. Japanese in eastern pocket attempt escape. Flame throwing tanks rout Japs.

D PLUS 24 - Back of Japanese broken by 5th Division although resistance is stiff. Mopping up and sealing up continues in other areas.

D PLUS 25 - The 4th Division wipes out enemy pocket on east coast. Other divisions advance in north to completely isolate Japs. All ORGANIZED RESISTANCE ENDS AT 1800. The mopping up operations continue for several days.

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## EARLY HISTORY

The Volcano Islands - or the Kazan Retto - were discovered in 1543 by Bernard de Torres, a Spaniard. Later visits were made in 1673 by an Englishman and in 1805 by a Russian. Because of the original discovery, Spain claimed jurisdiction - but this and other claims were never backed up. Not until 1887, the year that the Japanese came, were there any colonists on the Islands.

By 1891, Japan had a firm enough grasp on the Volcano Islands to incorporate them into the Ogasawara (Bonin Islands) Branch Administration. Foreigners were forbidden to land on the islands, and the Kazan Retto lapsed into obscurity from the outer world.

Iwo Jima - the largest of the Volcano Group - was the only island suitable for any relatively large population. Records show that in 1943 there were 1,019 civilianas on Iwo - farmers and fishermen from the Japanese homeland. About half the population worked at the sulphur plant and mines and the other half operated twelve small sugar mills scattered over the island. From February to May, when the sugar cane was ripe for harvest, men from the sulphur plant helped at the sugar mills. The island's only major exports were sulphur and sugar.

Most of the civilians lived at Motoyama, the only important village on the island and where the sulphur plant was located; the site of this village is now completely covered by Central Airstrip. The rest made up the villages of Kita Buraku (North Hamlet), Minami Buraku (South Hamlet), Higashi Buraku (East Hamlet) and Nishi Buraku(West Hamlet).

The islanders lived in small simple houses; the walls were of wooden frames covered with pandanus leaves; tin or galvanized iron was used for roofing; floors were of woods, covered with matting. The heavy rains provided a fairly adequate water supply for the colonists but some families with only one store tank would run low during the dry spells; better equipped families then pooled their water to aid the distressed. After the military overran the island, water became a serious problem. Examination of the dead revealed masses of sulphur in the intestines; drinking water obtained from the local well's was believed to be the cause of it.

The most prevalent complaints from the point of view of illness were colds and diarrhea. Diseases on the island were typhoid, para-typhoid and bacillary dysentery; there was no amoebic dysentery. The records show only a few cases of skin disease and very little influenza. The majority of the troops suffered from malnutrition as nearly all transports were sunk before reaching the island. There was little variety of diet. To supplement their rice and canned goods, the soldiers grew vegetables, fished and gathered bananas.

Iwo was under the jurisdiction of Tokyo and a village headman was sent here from there. Under him were leaders of the North, South, East, and West Sections. Taxes were numerous and heavy.

All civilians were evacuated in the summer of 1944. Work was discontinued at the sulphur plant on July 12th 1944, and at the sugar mills about the same time. After that, Iwo was strictly a military base with a Japanese Army-Navy garrison totalling 25,000 at the time of our invasion. Most of the buildings



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on the island were torn down by the military after the civilians left; the rest were destroyed by American air raids. Prior to the invasion, gasoline was so scarce that alcohol was used as a fuel for motor vehicles.

## GEOGRAPHICAL DATA

Of volcanic origin, Iwo Jima is a pear-shaped island, 4½ miles in length, and, at its widest point 2½ miles, comprising a total area of 4,850 acres. In the northern part of the island there are maximum elevations ranging from 340 feet to 387 feet; in the southern sector, Suribachi Yama has an elevation of 554 feet.

The coasts of Iwo are steep and rocky in the north while in the south there are beaches of black, coarse, volcanic sand. Throughout the island, vegetation is sparse - only low grass and small scrub growth. The surf is turbulent when the wind is in excess of 10 miles per hour.

The temperature ranges from an average of 62° F. in January to an average of 80° F. in August. During the summer months, temperatures as high as 95° F. are not uncommon. The rainy months are April, May, and June; the typhoon season is from September to November. Average annual rainfall is 60 inches.

The last time Mt. Suribachi erupted is not know. The Nips claim that it was silent during their 50 odd years of occupation, although from February 16th, three days before the assualt, until February 23rd when Old Glory was planted on its summit, the "yama" undoubtedly received more fire from our naval units than it has dished out seismologically. However, seismographs have had a workout from the slight earthquakes on Iwo. The last time was 7 years ago when the ground being prepared for the addition to the South Airfield was broken in several places. Another subterranean explosion occurred in the vicinity of the South Airfield in 1933 and left a large hole. The following day, after the steam had settled down, men were able to enter the cave for quite a distance. Too, the sulpur pit along the west shore that is now being used as a refuse dump has erupted frequently, emitting great lava boulders. As far as can be determined, none of the caves or labyrinthine tunnels on the island were built until after the first American air raid, June 15, 1944.

Iwo has no poisonous snakes, spiders or tarantulas.

## INVASION

For more than two months prior to D-Day, Iwo Jima had been bombed daily by air - and frequent shellings were launched by surface vessels of the U. S. Navy. For three days before D-Day, the American air and naval assault on Iwo was the heaviest in the history of warfare. The Fifth Amphibious Corps Landing Force, commanded by Major General Harry Schmidt, USMC, hit the beach at 9 A.M. on February 19, 1945. This force was comprised of the Fifth Marine Division, commanded by Major General Keller E. Rockey, USMC; Fourth Marine Division, commanded by Major General Clifton Cates, USMC; the Third Marine Division, commanded by Major General G. B. Erskine, USMC, and some 10,000 Army antiaircraft, amphibious and garrison troops commanded by Major General James E. Chaney, USA . Over 800 ships made the invasion armada.



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Against every conceivable handicap - surf conditions, ankle deep volcanic sand, lack of tactical surprise, and in spite of massed Japanese gun, mortar and machinegun fire - these American troops by nightfall had secured a firm beachhead on Iwo. Then followed twenty-five days of the most vicious fighting in the archives of our country's wars. Enemy forces entrenched on the slopes of Mt. Suribachi, on the southern tip of the island, offered stiff opposition to Marines scaling these heights. On February 23, 1945, Old Glory was raised atop Mt. Suribachi, and Marine forces continued the drive toward the northern sector of the island - an offensive measured daily on the right flank by yards.

Offering fierce resistance with heavy small arms, rocket and mortar fire from caves and heavily fortified pillboxes, the Japs were slowly compressed into the northern portion of the island. On March 16, 1945, organized enemy resistance was declared to have ceased - nevertheless, remnants of the enemy garrison trapped in the northwest corner of Iwo continued to resist with small arms, machineguns and mortar fire from caves and spider-trap foxholes. On March 26 command of Iwo Jima was handed ocer to the Army Garrison Force, and the long and steady mopping-up phase was begun by the 147th Infantry Regiment of the United States Army.

## THE PRICE OF VICTORY

The many rows of white crosses in Iwo's two American cemeteries give mute evidence that the price of victory was not low. American casualties up to March 16 were 16,806 - 3,844 killed, 14,535 wounded, and 427 missing. On V-J Day, September 2, American casualties totaled 21,588 - 4,763 killed, 16,424 wounded and 401 missing.

On March 16 Japanese casualties stood at 20,121 - 20,000 killed and 121 taken prisoner. In the mopping-up operations, the Japs lost 3,500 killed and 1,138 captured. On September 2 the total Japanese casualties stood at 23,500 killed and 1,259 taken prisoner.

## U. S. OPERATIONS ON IWO

The mission was the development of Iwo Jima as an airbase, and before the battle for Iwo was half over crippled combat aircraft were landing there. By V-J Day, 3,582 B-29's had found Iwo a safe haven - Superforts that might otherwise have been lost trying to reach Marianas bases. Wounded crewmen were given immediate medical attention.

The Seventh Fighter Command, commanded by Brigadier General Ernest Moore, USA, compiled an enviable record in air operations against the Japanese homeland and surrounding islands. Seventh Fighter Command P-51's not only escorted Superforts on bombing missions to Japan - they also made many fighter sweeps against the Empire. Seventh Fighter Command P-61's were instrumental in repulsing a large number of the attacking enemy bombers on Iwo.

Navy patrol and rocket-carrying planes ranged far from Iwo Jima to harass and destroy Japanese shipping between the Volcano Islands and the Nipponese homeland.



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## ENGINEERING DEVELOPMENTS

Development of Iwo Jima as an advanced airbase progressed rapidly with three airfields, North, Central and South, being completed - tending to make Iwo resemble a giant aircraft carrier. Central Field, longest of the three, has a length of 9,800 feet, approximately 1.8 miles. An intricate network of taxiways, hardstands and parking and refueling areas, connects North and Central Fields.

Even before the island was declared secure against organized enemy resistant, American forces had completed what the Japanese had termed an impossible feat - a two lane roadway up the steep sides of Mt. Suribachi. At the present date, Iwo is looped by a four-lane, almost completely paved road a road ten miles in total length.

Naval Construction Brigades and Army Engineers have changed the face of Iwo Jima.

## POINTS OF INTEREST ON IWO

Fifth Marine Division Cemetery - - -

Located below the South Airfield and overlooking West Beach is the Fifth Marine Division Cemetery - the resting place of 2,280 Marine, Army and Navy dead. Because of the nature of the soil (volcanic ash), grass has not been planted within the Cemetery - but daily sweeping gives it a refined atmosphere. Three hundred coconuts are planted around the perimeter of the Cemetery, outside of the white picket fence, and the palms will do much to enchance its view. The cemetery is laid out in the form of a cross.

Third and Fourth Marine Division Cemetery - - -

Located on East Beach, the site of initial American landings, is the Third and Fourth Marine Divisions Cemetery. Here are found the graves of 3, 160 American Marine, Army and Navy dead. As it is true of the Fifth Marine Division Cemetery, there is not any grass planted here, but a memorable display of headstones and memorials, carved by buddies of the Americans buried in the Cemetery, is to be seen. Another interesting feature of the Cemetery is the War Dog Burial Plot, at the South end, containing the graves of six Marine War Dogs killed in action on Iwo.

Mt. Suribachi Memorial Flagstaff - - -

Atop Mt. Suribachi, on the spot of the original flag-raising on February 23 by members of the 28th Regimental Combat Team of the Fifth Marine Division, is the Memorial Flagstaff, dedicated to the Americans who fought on Iwo Jima. Erected by the 31st Naval Construction Battalion, the Flagstaff was dedicated by Brigadier General Frederick M. Hopkins, Jr., USA, on October 2, 1945. Two plaques are located at the base of the Flagstaff one is of the original flagraising on February 23, the other bears the following inscription : - "Of all the Americans who served on Iwo Jima Uncommon valor was a common virtue - - Nimitz".



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General Kuribayashi's Cave - - -

In the elaborate system of caves that honey-combed the island, Lieutenant General Kuribayashi, Commander of the Japanese garrison on Iwo, had his well-concealed headquarters. This cave located at the northern tip of the island, was sealed by the Marines but was later reopened and cleaned out by the 147th Army Infantry Regiment. At that time, 46 Japs were taken prisoners and 52 found dead in the cave. No trace of the Japanese general was ever found, but his cave has become one of Iwo's main tourist exhibits.

Invasion Remnants - - -

Although Iwo's physiology has had an abruptly complete change, there are still several remnants of its bloody invasion. Throught the cliffs overlooking the invasion beach can still be found a number of huge, battered, concrete pillboxes, attesting to the fact that Iwo was the most heavily defended island in the world. On the invasion beach itself, remnants of Jap landing craft - victims of pre-invasion bombardment - are found. Also seen on the site of American assault landings are the twisted, rusted hulks of American ships beached during the invasion. Throughout the more congested terrain of the island can still be foound many of the Jap caves in which their last-ditch stands took place. Also reminiscent of the battle for this island, and the air bombardment preceding the invasion, are the wrecks of both American and Japanese planes dotting the landscape of Iwo.

Enemy Cemeteries - - -

Situated between South and Central Airfields is the largest of the two Jap cemeteries, in which are buried 1,972 enemy dead. The other cemetery, located at the foot of Mt. Suribachi, containes 208 Japanese dead. The total number of Japs killed on Iwo since D-Day is 23,500 - the majority not buried in the two semeteries are sealed up in the numerous caves on the island.

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# The BATTLE for TINIAN

Tinian Island, approximately 10 miles long and 5 miles wide, is about two-thirds the size of Saipan. The topography of Tinian is much different from that of the other Marianas Islands; it does not have the usual rugged mountains and is largely a broad plateau. This fact made Tinian one of the best locations for B-29 bases and helped to make possible an easier campaign for U. S. troops.

Following an extensive land, sea, and air bombardment, Marines landed on Tinian where the Japs believed such an operation almost impossible. Tinian was taken in a sweeping 9-day campaign during which almost the entire Japanese garrison was wiped out at a very low American loss.

In command of the amphibious operation against Tinian was Rear Admiral Harry A. Hill who had previously directed the attacks against Tarawa and Eniwetok. Commanding the assault troops (2d and 4th Marine Divisions) on Tinian was Major General Harry Schmidt.

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# The BATTLE for TINIAN

24 JULY - "D" DAY - Following daily naval and air attacks plus artillery fire from Saipan the 2nd and 4th MARINE DIVISIONS land on Tinian against very weak opposition. 25 JULY - Japanese attack at dawn is repulsed. Following naval and artillery preparation marines advance half way across island, take one-third of Ushi Point Airfield and extend beachhead to three and one half miles. 26 JULY U. S. forces take Ushi Airfield and entire north quarter of island, including Mt. Lasso. 27 JULY - supported by naval vessels and P-47's, marines make gains of three miles. 28 JULY - Gurguan Point Airfield falls. Marines virtually unopposed in some areas. 30 JULY - Following naval and air bombardment, Tinian town falls. 31 JULY - Japs driven deep into southern end of island. Counter-attacks repulsed. 1 AUGUST - Organized resistence ends at 1855 with the remaining Japanese caught in a pocket at Lalo Point.

## The B-29s ON ... TINIAN

15 November 1944 - Construction begins on first B-29 base (North Field) on Tinian.

22 December 1944 - First B-29 lands on Tinian.

10 February 1945 - First B-29 mission to Japan from Tinian (313th Wing).

5 May 1945 - Second Tinian Wing (58th) on mission to Japan.

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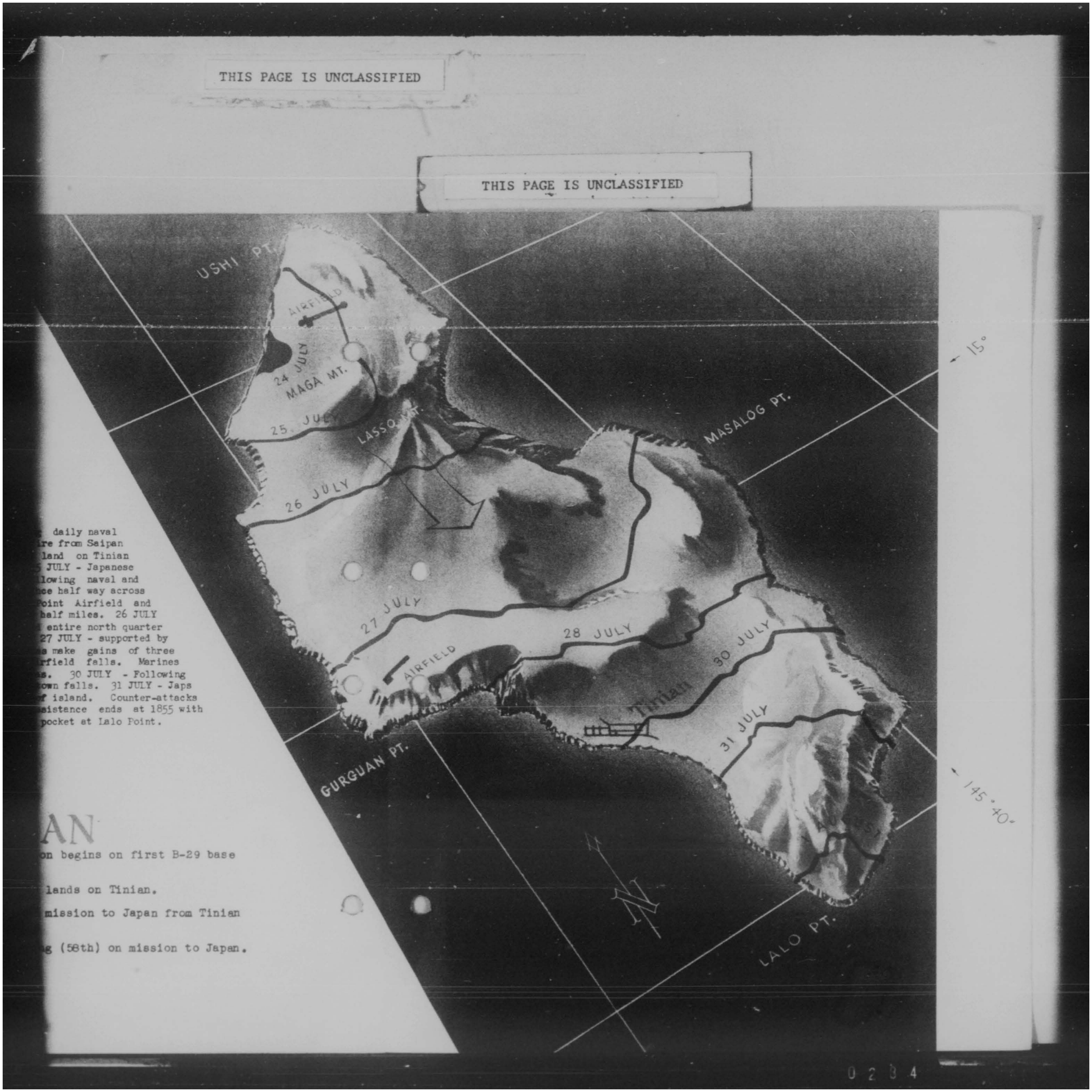


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Tinian is located at Lat. 14°57' N., Long 145°37' E., about two and three-fourths miles SW of Saipan and five miles NE of Aguyan.

The island is 12.6 nautical miles long and has a maximum width of 6.2 miles. Topography is generally flat and terraced. Steep slopes and cliffs divide the island into plateaus although, as a whole, Tinian is lower and flatter than the other Marianas. It is only 15 feet above sea level in the west but rises to 150 feet or more toward the east. The two highest points are in the central and southern parts of the island where the hills reach heights of over 500 feet. The northern part of the island is flat, and now contains four completed VHB airstrips, with auxiliary taxi-ways, and service areas.

The area of northern Tinian extending east from the western coast, is also flat and located there completely constructed, are four VHB air-strips, auxiliary taxiways, and service areas.

The southern plateau area, including an old Japanese airstrip, is suitable for small aircraft.

Approximately 90% of the land area of the island is arable and was formerly cultivated for sugar cone by the Japanese.

The average temperature for summer months is 71.5 to 89.0. Rainy season is from 15 June to 15 October. During July, August, and September the prevailing winds are NE, with an average velocity of 6.2 m.p.h. No fog has been reported.

Tinian like Saipan, was probably first visited by Magellan in the early sixteenth century. In 1564 it was placed under Spanish sovereignty although no attempt was made to wxploit the population and land until the latter part of the seventeenth century. The Spanish ship "Concepcion" was wrecked off the shores of Tinian in 1638 and some of the crew became the first Europeans to settle in the Marianas.

Tinian was the source of many uprisings against Spanish oppresion, and as a result of diseases, epidemics, and battle casualties the small population was eventually wiped out. Those remaining were finally taken to Guam and for many years Tinian remained uninhabited. When this island was sold by Spain to Germany, after the Spanish-American war, a small population of Spanish, Filipino, and Chamorro blood had resettled Tinian. Under German rule efforts were made to induce further settlement but with little success.

Tinian was seized by the Japanese at the out break of World War I and later was ceded to Japan under a League of Nations mandate. The island was cultivated extensively for sugar cane for which many Japanese were brought there by the Japanese Southern Development Company either as employees or tenant farmers.

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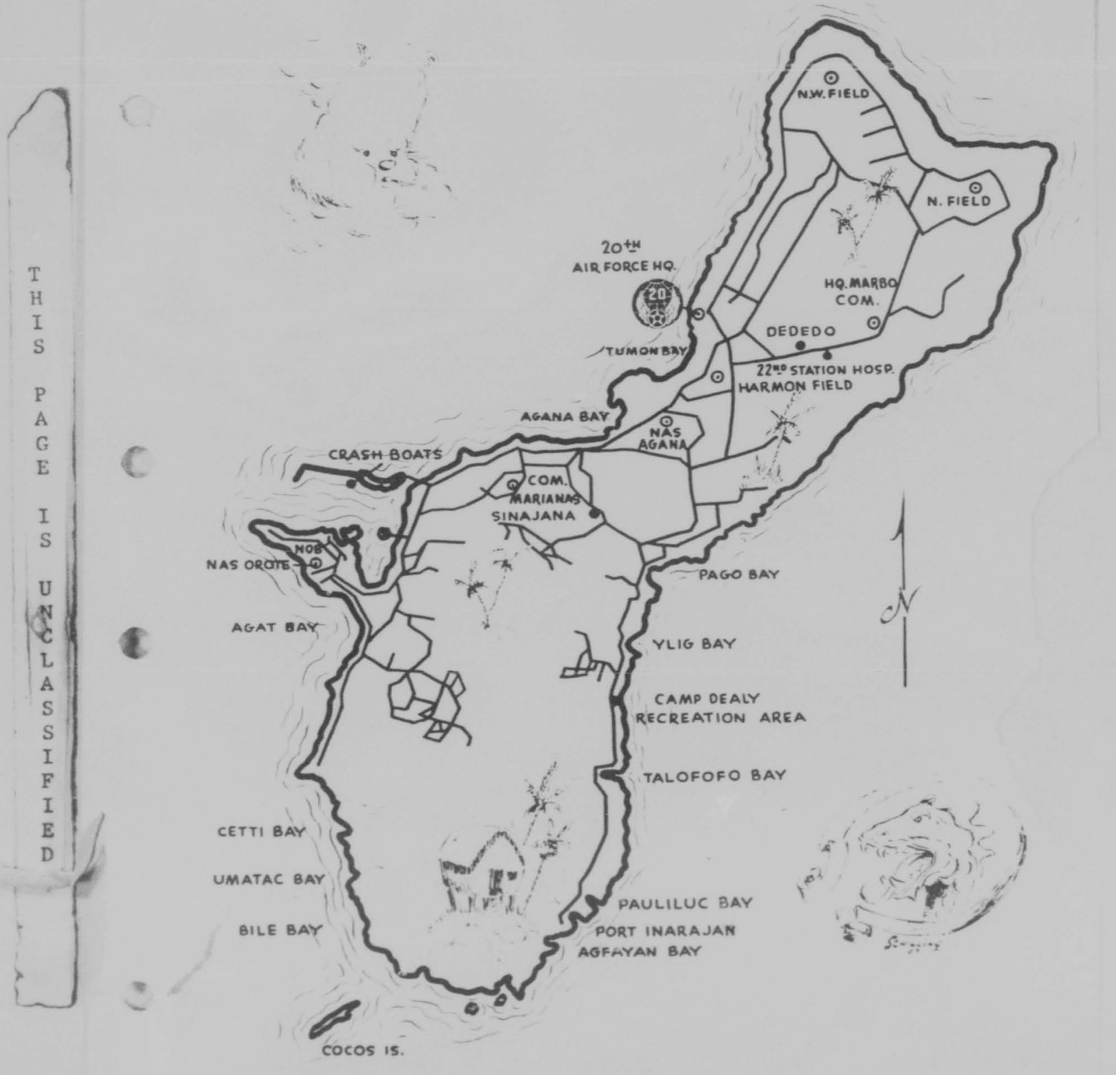


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**Report on Bombing Activities of the 20th Air Force Against the Japanese Home Islands by Colonel J. B. Montgomery, AC, Deputy Chief of Staff for Operations of the 20th Air Force.**

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Gentlemen, in starting this discussion, I would like to make it clear that the operations described, this brief represents only the operations of the 20th Air Force. We do not include the operations which were launched from the CBI or the 58th Wing in the earlier days.

I would like to take a few minutes to refresh the memory of everyone here concerning the way in which the Marianas force of B-29s was built up.

In October of last year, about 13 months ago, the 73rd Wing, under the command of General O'Donnell, who commanded the position at Isley Field, Saipan. This wing became operational on the 24th of November, on which date it sent its first mission against the Nakajima aircraft plant, located just West of the City of Tokyo. This first mission marked the start of the B-29 operations from the Marianas.

The 73rd Wing on the date of its first mission had only about 119 aircraft on hand. It was able to get off 111. The next Wing to move into position was the 313th Wing which arrived in the middle of December and became operational in the early part of February. The third Wing was the 314th Wing under the command of General Power, the 313th Wing being commanded by General Davies. The 314th Wing moved into position at North Field, Guam and became operational the latter part of February. The fourth Wing (58th Wing) under the command of General Remey, was moved into position at West Field, Tinian, being redeployed from the CBI, and it became operational in the early part of May. The last Wing of the 20th Air Force was the 315th Wing. That Wing moved into position at West Field, Guam, under the command of General Armstrong, and it became operational the latter part of June.



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It is, therefore, seen that the strength of the 20th Air Force started with an average of 93 aircraft in the Theatre in November of 1944 and was steadily built up through the Spring and Summer of the next year until, by the latter part of June, it had reached a strength of slightly under 1000 B-29 aircraft. Its capability was built up steadily also during this period and moving along rapidly during the middle of March.

I would also like to mention the fact that in the 20th Air Force we had the 7th Fighter Command stationed on Iwo Jima, and it provided long range fighter escort to our B-29 strikes. Even to sending them against Japan in independent fighter sweeps against their air fields and installations.

The 7th Fighter Command arrived at Iwo Jima in March and ran its first mission in early April. Its strength rose from 193 fighter aircraft in the beginning to 260 by August.

Just a few words now on the organization of a B-29 Wing. I would like to point out that each Wing consists of four Bombardment Groups and that each Group consists of three squadrons. You have in each squadron a total of 15 aircraft, making 45 per group and 180 per wing.

I will now go into a brief description of the history of the operations of the 20th Air Force, touching upon those important factors which affected the overall operation. I would like to call your attention to the chart which you now see in front of you. I use this chart simply as a guide to present to you the overall operations and to bring out more clearly the changes in our operational trends.

In the center section of the chart I have shown the effort of the command. From day to day the various attacks which were sent against Japan which are shown by vertical columns plotted as to the number of aircraft which participated zero to one thousand. You can see at a glance that during the initial months of operation we were able to launch attacks in the strength of from 70 to 90 aircraft, whereas, during the latter period of operation the strength of our attacks each day they were scheduled increased to as high as 850 aircraft. On the last day of the war, the 14th of August, we were able to send against Japan



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a total of 821 B-29s.

For the day attacks we have represented each strike by a red column. For the night attacks we have represented the strikes by a black column so that you will be able to see at a glance roughly the ratio of our day to night attacks.

In the column in the section below the one I have just referred to I have indicated operational trends to include altitude, bomb load, loss rate. You will be able to see at a glance that our altitude for daylight bombing started around 30,000 feet and continued downward, taking an abrupt drop during the month of March. The night bombing altitude started in low, around 5,000 feet and increased until toward the end of the war we were operating at around 12,000 to 14,000 feet. You will note that bomb load per aircraft airborne against the enemy started off around 3 tons and gradually increased at first and then abruptly during March until toward the end of the operations we were carrying in our aircraft that were sent against the mainland a little less than 8 tons on an average.

The loss rate is also interesting. You will note that for each 100 aircraft airborne against the enemy during the month of December, the intial operations, we lost 3.8 on an average. This figure increased during January for each 100 aircraft that were airborne we lost 5.7. This was our worst month. The loss rate from this point continued downward and dropped abruptly during March and, at the close of operations, we were losing an average of .4 aircraft for each 100 sent against the enemy.

In the top section of the chart I have attempted to indicate in a rough way the effectiveness of the operations, the various missions, by including the damage to the targets which were attacked throughout the period of operations. For the industrial pin point priority targets I have represented the damage in percentage of the route of the area zero to 100%. For the urban areas you will find the damage represented in a column plotted against the scale zero square miles to 15 square miles destroyed. The bottom part of the chart contains several factors of lesser interest, such as total sorties, total fly-

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ing time in hours per month, average gas consumption on a basis of individual aircraft, which factors become of more interest later.

I will now review for you briefly the overall operation of the 20th Air Force. I will start by saying that our original target directive followed the usual lines of a strategic air plan to destroy the capacity of the enemy to wage war by destruction of his home industry and reduction of his economy.

The highest priority targets in the strategic system were the units of the Japanese aircraft industry, with engine plants being the very highest in our priority system of targets.

We, therefore, started off in an initial attack on 24 November by sending 111 aircraft against the Nakajima aircraft plant, west of Tokyo. From the 24th of November until the 9th of March we operated in what I would like to describe as Phase One. From the 9th of March until the end of the war, our operations are listed as being under Phase Two.

Phase One is characterized by several things. One, the operations were very uniform in nature. We were working against pin point priority targets. We bombed through daylight hours in formation generally, in column of squadrons; took off by daylight and returned by night; and we operated at high altitude. It was, in general, a phase of tactical experimentation, during which period we attempted to determine several things - capability of the B-29; the most efficient system for employing this weapon; and the ability of the Japs to defend themselves against attacks by this weapon.

From the 24th of November until the 9th of March, we were operating under the system I have just described, and a total of 22 major strikes were sent against the Japanese mainland. As you will see, all of these strikes were conducted during daylight hours, except one very small attack, employing approximately 30 aircraft, which was sent against Tokyo during the hours of darkness.

These attacks were launched at high altitude, averaging 28,000 to 32,000 feet. Many difficulties were experienced during this period. Difficulties which contributed directly to unsatisfactory bombing results and to a general unsatisfactory condition as pertains to the

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overall effectiveness during this period. The most serious obstacle which confronted us during this period was the weather. The winds at levels around 32,000 to 28,000 feet were high. They averaged from 125 to 140 miles an hour during the months of November, December and January, and occasionally they rose in intensity to a force approximating 200 miles an hour. These high winds made bombing problems extremely difficult. They made it necessary for us to approach the targets usually from the west. They made it impractical to come in from either the north or the south, since from these directions we would experience excessive drift, and they made it impractical to come in from east since coming upwind our ground speeds would be reduced to very low levels, around 100 to 150 miles an hour; and in general, we were coming over heavily defended flak areas and our battle damage would, therefore, have been very high had we consistently approached targets upwind. You might say that the flexibility of our attacks was reduced a great deal by the very high winds encountered aloft.

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Also, another serious obstacle was the cloud coverage in which it was difficult to forecast at our bombing levels between intervening clouds. It consistently interfered with visual bombing. In addition we had the enemy to contend with. Early in our operations he found out that we were interested in his installations of aircraft industry. He determined during the month of December that we were going to bomb his installations by daylight high level attacks in formation. He determined that the pattern to be established called for our attacks to fall in the mid-afternoon since our take-off from the Marianas was restricted to daylight. He also knew that having one wing in operation during the months of November, December and January, with two wings coming in February, he knew in just about what strength to expect our daily attacks to be in.

The efficiency of the enemy's defenses, therefore, increased until during the middle of January. As I have pointed out, the attacks from enemy fighters was very severe. For every B-29 that we put over Japan, we averaged 7 fighter attacks. Anti-aircraft was also becoming more efficient from the enemy's standpoint. Our losses, therefore, increased to 5.7 aircraft per 100 airborne against the enemy during



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the month of January.

In summarizing Phase One, I would like to point out that in 22 major strikes dispatched, this period representing approximately 2100 sorties and carrying some 7,000 tons against Japan, that we damaged the following installations of the enemy: Three aircraft plants were damaged as follows: The Mitsubichi Plant In Nagoya, receiving 53% damage. Nakajima Aircraft Plant in Ota was damaged 32%. The Kawasaki Aircraft Plant in Akashi received 38% damage.

We also accomplished one square mile of damage to urban areas of Tokyo, Nagoya and Kobe.

The cost in B-29 aircraft for this period - approximately 100, and the cost in crews during this period, air crew personnel, was approximately 400.

You can readily see that the Commanding General was disatisfied with the results of his operations to date. He considered that something had to be done to improve immediately the effectiveness of our attacks. His decision was, therefore, made to change the nature of B-29 attacks as follows:

He planned to initiate immediately a system of low-level attacks against the principal urban areas of Japan. These low-level attacks were designed to be repeated as frequently as possible, carrying as large bomb loads as possible, and designed to burn out the important urban area concentration of Japan.

As is known to everyone here, these attacks were not designed to terrorize the Japanese population. They were designed to destroy the main industrial installations and the many small types of industrial factories that existed in the urban areas of Japanese cities. The size of the plants depends to a large extent upon the products that are produced in the home type industries, and employing small numbers of people. These are scattered throughout the urban areas and could not be destroyed by pin-point bombing due to the fact that they are too numerous and can not be located. The only effective system of destroying them is by incendiary attacks on the urban areas.

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In preparation for the series of low-level incendiary attacks on the principal cities of Japan several things were done

Immediate training measures were initiated to prepare the crews for this new tactic. Incendiary bombs were put into position. Maintenance checks were devised especially to permit us to launch this series of attacks in rapid order.

On the 9th of March, the first low-level attack was sent against the city of Tokyo, and approximately 330 aircraft were airborne. The attack was very successful, as you know. Apparently, the Japanese were taken by surprise and approximately 16 square miles of built up area was destroyed in this first attack. Two days later, we hit Nagoya. Two days later, we hit Osaka. Three days later, Kobe was struck, and two days later, a return attack was sent against Nagoya.

The 5 missions, totaling some 1600 sorties, lifted over 9,000 tons of bombs and destroyed over 30 square miles of built up area. You will note that in these 5 missions, which lasted from the 9th to the 18th of March, we picked up over 2,000 more tons of bombs and carried them to Japan than were carried during the entire Phase One of operations, which lasted from 24 November until the 9th of March. Our losses were very light. This operation, the 5 missions against the big cities, only cost us 22 aircraft, as compared to the 100 B-29s that were lost during Phase One. Apparently, the Japanese were taken by surprise and were unable to organize their defenses to meet night low-level attacks. We wondered if they would be able to meet and effectively counter these attacks.

After the last attack of the series of 5, against Nagoya, we were completely out of incendiary bombs, and had sent some urgent requisitions back to the mainland. While waiting for incendiary bombs to be brought to the Marianas, the Commanding General tried a new system. He tried to exploit the system of night low-level attacks by sending missions against the pin-point priority targets. The plan was to illuminate these targets by flares and to attempt to bomb them at night by individual aircraft at from 5,000 to 8,000 feet. In this

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system we sent approximately four major attacks against the following plants. We attempted to bomb Mitsubichi in Nagoya, Nakajima plant in Ota, the Shezuoka plant at Shezuoka, and Nakajima's aircraft plant outside of Tokyo. Although the Ota attack was fairly successful, in general, this system was not considered to be effective because of the fact that insufficient illumination was produced to permit the bombardiier to track the targets through their optics. Although the pilots and bombardiers could see the targets with the naked eye, it was impossible without marker bombs, which we did not have in the theatre, for the bombardier to find the target and track it with his telescope. We, therefore, ordered marker bombs and discontinued this system of attacks.

Shortly after this, the invasion of Okinawa started and B-29s were called upon to assist in this invasion by neutralizing enemy air fields in Kyushu. We started in earnest about the 17th of April in sending our strikes against about 17 fields in Kyushu. We continued to bomb these fields until about the 11th of May. During this period, we sent about 2,000 B-29s against these air fields and had a very successful operation as far as neutralization is concerned. The weather was very good and we succeeded in destroying most of the hangars and shops and installations on these air fields; and also destroyed a number of aircraft on the ground.

I would say that the mission was very successful and accomplished its purpose, the purpose being to prevent the Japanese from marshalling any large scale attacks, in the numbers of 100 to 200 aircraft, and sending them against Okinawa from bases in Kyushu. This was done and done successfully, and, you know, the Jap was only able to send 50 to 75 aircraft on a daily spread against individual units in the Okinawa area. However, approximately 2000 B-29sorties were diverted from the primary target mission. On the 11th of May, the Kyushu air field neutralization program was discontinued, and our forces put back at their strategic bombing mission. By that time we had received additional incendiary bombs and we started in to complete the incendiary destruction of the large Japanese cities. This was done by large scale attacks on Tokyo, Nagoya, Osaka, Kobe and Yokohama.

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By the middle of June we had succeeded in destroying for all practical purposes the industrial productive capacity of the cities I have just named. Our missions were then sent in maximum effort and as far as we could range them against Japanese targets, following the system of operation I will now outline.

When the weather forecast indicated a reasonable chance of visual bombing, our strikes were sent out in daylight against important industrial pin-point targets. If the weather forecast indicated no reasonable chance of visual bombing, our strikes were sent out at night against the Japanese urban industrial areas with incendiary bombs.

We, therefore, had two parallel systems of targets, industrial targets - pin-point targets - and the urban industrial concentration. This permitted us to send forces against Japan as fast as we could mount the missions. We employed maximum effort until the end of the war.

I would like to invite your attention to the fact that the percent of utilization of equipment increased a great deal over that standard established during Phase One. You will note that during Phase Two aircraft were flown on an average of over 100 hours per month, as compared to the 50 and 60 hour standard set up during Phase One. You will also notice that the average flying time per crew assigned increased from 37 to 45 hours during Phase One to over 90 hours during Phase Two. That, of course, is based on the total crews assigned. Actually, for the crews available to participate in each combat mission the average flying time per month during Phase Two was running approximately 110 hours to 120 hours per month. We knew that we could not maintain this program unless additional crews were provided, and Washington was requested immediately to send additional crews to the Marianas. This program was approved. However, the crews did not arrive in time to alleviate the situation. I think that had the war gone on, that we would have had to slacken off a bit on our effort. But, in short, with the crews that were promised us by Washington, we would have been able to regain the tempo that we had established since the 9th of March.

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As a result of the very effective fire raids against the large cities, the morale of the combat crews and the maintenance personnel increased immeasurably. Everyone was willing to work long hours and to do anything to continue the effort. They all felt that it was definitely paying off.

You will note that during Phase Two, when bombing during daylight hours, we bombed from altitudes around 17,000 feet on an average Over heavily defended areas, we sent our units in from 18,000 to 22,000 feet and, over lightly defended areas, our units were sent in at from 10,000 to 15,000 feet, maintaining an average of about 17,000 feet for the daylight operations.

At night we started in during early March at altitudes from 5,000 to 8,000 feet, and this continued to increase during the rest of the war until by August we were bombing the smaller cities at from 10,000 to 12,000 feet. The increase in night altitudes was based on the fact that the targets became smaller and it was necessary to raise the altitude to permit synchronous radar bombing. Synchronous radar bombing can not well be accomplished at altitudes as low as 5,000 feet.

I would like to say a word on the bomb load. Our bomb loads increased from Phase One, during which time we were carrying approximately 3 tons, to about 7½ tons during Phase Two. This, of course, was made possible by the fact that the operating altitude was reduced from an average of 30,000 to 17,000 feet. This made a great difference in the amount of gas that was required to send a B-29 from the Marianas to Japan and back. Operating in formation at 30,000 feet, we were burning on an average of 512 gallons per hour per aircraft during December, 470 gallons during January, 440 gallons during February. When we lowered our altitude to medium levels, and when we started in operating at low levels at night, the average gas consumption dropped to 402 gallons in March, 420 in April, 418 in May, and so forth. This indicates, roughly an amount of about 100 gallons per aircraft per hour, and, during the 15 hours that were required to fly from the Marianas to Japan and back, we saved for each aircraft 1,500 gallons. When you convert this saving into weight, it amounts to 9,000 lbs. You add

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the 9,000 lbs to the 6,000 lbs that we were carrying, the bomb load during Phase One, and you come out with the bomb load that we were able to carry during Phase Two, of about 16,000 lbs.

Our bombing accuracy also increased a great deal during Phase Two over the standard established in Phase One. During the early operations, we were bombing from levels of 30,000 feet, with an accuracy of approximately 12% of our bombs within 1,000 feet. This increased tremendously when we lowered our altitude to a point when, toward the latter part of operations, we could expect 40% to fall within 1,000 feet.

It is also worth noting that at lower levels we were able to see the target a higher percentage of the time. During Phase One, about 70% of the aircraft that were sent against Japan found the targets closed in and had to bomb by radar. During Phase Two, approximately 30% of our aircraft found targets closed in and were forced to bomb by radar. I speak of those missions that were sent out during daylight with the intention of bombing by visual means. All of these factors add up to one important thing. That the overall effectiveness of the 20th Air Force went up by leaps and bounds as a result of the increased accuracy, increased bomb load and the increased frequency of attacks. We estimate that during Phase Two we could do with 30 planes what 250 planes were required to do in Phase One. This is important since it permitted us to spread out and attack many targets on days when the weather was good, and to attack many urban areas each night that we sent out a strike.

To give you an idea of the capacity, the capability of the 20th Air Force during Phase Two, I would like to take a mission on any particular night that we operated and we operated about 12 times a month. We were able to strike the four most important cities and one oil installation. This means that during one month we were capable of attacking, and attacking effectively, approximately a total of 48 cities and 12 oil installations. When the weather permitted us to go out during daylight, we were able to break up and strike almost simultaneously 12 pin-point industrial targets.

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I would like to discuss total tonnage. We started out during November by taking 735 tons against Japan. In December, this figure increased to 1,700, in January about 1,600, and in February it increased to 2,500. In March, as a result of coming down in our bombing level and initiating low-level bombing, and also by the fact that we were receiving additional planes and building our force up, our capability increased to 13,000 tons during March. During April, it increased to 16,000, 24,000 during May, 32,000 during June, 42,000 during July and, during the half of August which we operated, we carried about 20,000 tons against Japan. It was our plan to level off at approximately 50,000 tons per month against Japan. I would like to point out that this 50,000 tons could be dropped with great accuracy from the levels that we were operating at.

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One word about the 315th Wing. This Wing was sent out to us with special equipment. All guns were removed except the tail turret. The Wing had B-29s also equipped with the Eagle Radar - Q 7. Our other Wings of standard B-29s, as you know, had upper and lower turrets, tail turrets, and Q 13 radar sets. With this special equipment of the 315th Wing we decided to send this Wing against a separate system of targets - the oil industry. This system was selected for several reasons. Installations of this industry presented targets which could be located and bombed by radar. They were coast line objectives, and gave us the opportunity to test the efficiency of the Q 7 radar. We desired to have this Wing bomb targets that were not being attacked by other wings, so we put them on a separate system. From the time they started operations during the latter part of June until the end of the war, they were very successful in knocking out approximately 13 of the oil installations of Japan. They were also very fortunate in having a very low loss rate. They only lost 3 or 4 aircraft during the entire period of their operations.

I would like now to summarize briefly the operation as a whole. From the period 24 November until 14 August, we sent against Japan some 28,800 combat B-29 sorties. This effort carried 157,000 tons to Japanese targets. In addition to the bombing strikes, we initiated



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during the latter part of March and continued the effort to the end of the war - mining strikes. These mining strikes succeeded in mining all of the harbors of Japan and the Eastern harbors of Korea and Manchuria. Some 1,400 B-29s carried 12,000 mines to these waters.

As a result of our operations against Japan, a total of 334 B-29s were lost while participating in combat operations. A total of about 440 were lost overall, indicating that a little over 100 B-29s were lost back in the Marianas on training flights, on shake-down missions or were sent back to the States as being war-weary. The operations also cost us in crew personnel, approximately 2,400. The cost to Japan was very heavy though. Japan lost 66 cities, 59 of these cities being almost completely destroyed. 7 of them were partially destroyed. The total destruction of built-up urban areas amounted to 178 square miles or 113,000 acres. In addition to the urban area destruction, the Japanese lost over 513 important industrial factories - all contributing to the war effort. Of these factories, approximately 25 of them were aircraft factories, 8 of them were major arsenals of Japan, and 13 of them were installations of Japanese oil refinery storage.

The mining effort resulted in the sinking or damaging of approximately 1 million tons of Japanese ocean-going equipment. It also resulted in the bottling up of all of the major harbors of Japan.

The combined operation of our B-29s and supporting fighter aircraft resulted in the destruction of approximately 1,000 Japanese aircraft destroyed and 700 probably destroyed. The cost to us in friendly fighters was 204 P-51s and P-47s.

I would like to point out a very interesting fact. I mentioned that a total of 157,000 tons of bombs were dropped by B-29s on Japanese targets. By the way, this also includes the mines that were carried to Japanese waters. These 157,000 tons were taken into Japan in a period of 37½ weeks. You will note by the chart that the strength of the command was being built up throughout the entire period. By the end of the war, we had our full force in position.

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We had learned to employ the force most efficiently. We were in position to take back to Japan that same 157,000 tons in 11 weeks instead of 37½ weeks, and we were in a position to deliver that 157,000 tons with greater accuracy and more devastation.

This comment would not be complete without reference to the employment of the atomic bomb. As you know, 2 bombs were dropped, 1 on Hiroshima and 1 on Nagasaki by B-29 aircraft during the early part of August, just before the war stopped. This entire project was very secret and the security was very carefully guarded. Very few people in the 20th Air Force knew anything about the program. General LeMay and a few people in the headquarters, and the Commanding Officer of the 509th Group plus the people in his organization knew. We all felt the atomic bomb was dropped at just the right time to give the Japanese a good reason for getting out of the war. The bombs were very effective, as you know, and accomplished their purpose. I think it was all that was needed for the Japanese to feel that any further attempts by themelves to carry on the war would result in national suicide.

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# TABLE I
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## URBAN AREA TARGETS

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| Obj. Area | Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | Bombs on Target: H.E. Type | H.E. Fusing | H.E. Tons | I.B. Type | I.B. Fusing | I.B. Tons | Aiming Point MPI | Reference: 20th AF Litho Mosaic | RESULTS: Based on 20AF CIU Damage Assessment Reports (D/A) and Flash Reports (F/A) as indicated. Reference to numbered targets is to AAF designations. Specific numbers are those of targets also attacked as precision targets. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.5 | AOMORI | 298 | 28 July | 58th | 61 | 14,500 | | | | E-46 | Open 5000' over target | 546.5 | 069042 | 90.5-Aomori Urban area | Destroyed 0.50 sq mi or 29% (F/A #392). |
| 90.9 | HAGAOKA | 308 | 1 Aug | 313th | 125 | 12,500 | | | | E-46<br>M-47 | Open 5000' over target<br>Instantaneous nose | 1169.6 | 070073 | 90.9-Hagaoka Urban area | Destroyed 1.33 sq mi or 65.5% (F/A #389). |
| 90.10 | SENDAI | 257 | 9 July | 58th | 123 | 10,500 | | | | AN-M47A1<br>AN-M47A2 | Open 5000' above target<br>Instant, nose | 911.3 | 057111 | 90.10-Sendai Urban area | Destroyed 1.22 sq mi or 27% (D/A #147). |
| 90.11 | TOYAMA | 307 | 1 Aug | 73rd | 173 | 12,500 | | | | M-47<br>M-17<br>E-46 | Instant. nose<br>Open 5000' over target<br>" 1-5000' " | 1599.1 | 106107 | 90.11-Toyama Urban area "A". | Destroyed 1.87 sq mi or 99.5% (F/A #389). |
| 90.13 | ISEZAKI | 330 | 14 Aug | 73rd, 314th | 86 | 15,300 | | | | M-47<br>E-46 | Instant. nose<br>27.2 sec nose 28.2 tail | 829.1 | 100091 | 90.13-Isezaki Urban Area | No Post-strike photos. |
| | KUMAGAYA | 329 | 14 Aug | 313th, 314th | 81 | 14,800 | M-56 | | 8 | M-47<br>E-46<br>M-17 | Instant. nose<br>27.2 nose-28.2 tail<br>Open 5000' over target | 665.7 | 095065 | 90.13-Kumagaya Urban Area | No Post-strike photos. |
| | HAKKASHI | 313 | 5 Aug | 313th | 92 | 15,500 | M-64 | Proximity nose | 15.2 | E-46<br>T4E4 | Open 5000' over target<br>Open 3000' below A/C | 176.6 | 102072 | 90.13-Hasabashi Urban Area | Destroyed 0.93 sq mi or 40% (F/A #401). |
| | UTSUNOMIYA | 263 | 12 July | 58th | 115 | 14,000 | | | | AN-M47A2<br>E-46 | Instant. nose<br>Open 5000' over target | 802.9 | 114104 | 90.13-Utsunomiya Urban Area | Destroyed 0.68 sq mi or 32% (D/A #163). |
| 90.14 | CHIBA | 251 | 6 July | 58th | 124 | 10,500 | | | | T4E4<br>AN-M47A2<br>E-46 | Open 1000' below A/C<br>Instant. nose<br>Open 5000' over target | 889.5 | 085094 | 90.14-2145-Chiba Area | Destroyed 0.85 sq mi or 43.4% (D/A #135). |
| | CHOSHI | 279 | 19 July | 313th | 91 | 11,000 | T4E4 | Open 1000' below A/C | 31.2 | E-46<br>M-47 | Open 5000' over target<br>27.5 sec. tail<br>Instant. nose | 673.6 | 083084 | 90.14-Choshi Urban Area | Destroyed 0.48 sq mi or 43.0% (D/A #150). |
| | HITACHI | 278 | 19 July | 73rd | 126 | 13,000 | | | | M-47, M-17,<br>E-46, E-36 | | 963.2 | 115121 | 90.14-1475-Hitachi Area | Destroyed 1.08 sq mi or 78.3% (D/A #161). |
| | MITO | 309 | 1 Aug | 314th | 160 | 12,800 | | | | M-47<br>E-46 | Instant. nose<br>23.5 sec. tail | 1542.2 | 053101 | 90.14-Mito Area "A" | Destroyed 1.70 sq mi or 65.0% (D/A #170). |
| 90.15 | FUKUI | 277 | 19 July | 58th | 127 | 13,000 | | | | M-47, E-46 | | 953.4 | 051085 | 90.15-Fukui Urban Area | Destroyed 1.51 sq mi or 84.6% (D/A #151). |
| 90.16 | KOFU | 254 | 6 July | 314th | 131 | 14,000 | | | | AN-M47A2<br>AN-M17, E46 | Instant. nose<br>Open 5000' over target | 970.4 | 062085 | 90.16-Kofu Urban Area | Destroyed 1.30 sq mi or 65.0% (D/A #134). |
| 90.17 | HACHIOJI | 306 | 1 Aug | 58th | 166 | 15,000 | | | | M-47<br>M-17 | Instant. nose<br>Open 5000' over target | 1560.1 | 059078 | 90.17-Hachioji Urban Area | Destroyed 1.12 sq mi or 80.0% (D/A #166). |
| | HIRATSUKA | 274 | 16 July | 314th | 129 | 13,000 | | | | AN-M47A2<br>AN-M17 | Instant. nose<br>Open 5000' over target | 1162.5 | 084080 | 90.17-1336-Hiratsuka Area | Destroyed 1.04 sq mi or 44.2%. Damaged five (5) numbered targets (D/A #158). |
| | KAWASAKI | 68 | 15 Apr | 313th, 314th | 194 | 8,400 | M-64 | | 37.6 | E-46<br>M-47 | | 1072.4 | 103035, 081022 | 90.17-Kawasaki Urban Area | Destroyed 3.70 sq mi or 32.8%. Damaged twenty five (25) numbered targets including three priority electronics plants. (D/A #47). |
| | TOKYO | 9 | 29 Nov | 73rd | 25 | 22,000 | T4E4 | | 17.64 | M-18 | | 64.52 | | | Damage negligible. |
| | | 38 | 25 Feb | 73rd, 313th, 314th | 172 | 27,250 | | | 42.3 | | | 411.4 | AAF Target Chart No. | 90.17-1394 | 1.0 sq mi destroyed or damaged (D/A #13). |
| | | 40 | 9 Mar | 73rd, 313th, 314th | 279 | 7,050 | | | | | | 1665 | " " " " " " | | Destroyed 15.8 sq mi including 11 AAF numbered targets (D/A #17). |
| | | 67 | 13 Apr | 73rd, 313th 314th | 327 | 8,250 | AN-M64<br>M-65 | Instant. nose<br>Non-delay tail | 81.9 | M-47<br>E-46 | Instant. nose<br>2 tail fuses 20 sec. | 2037.7 | 049081, 036101<br>068098 | 90.17-201 thru 209 Tokyo Area | 11.4 sq mi destroyed (D/A #81, 114, 123). |
| | | 69 | 15 Apr | 73rd | 109 | 9,050 | M-64 | Instant. nose<br>Non-delay tail | 14.5 | M-47, E-46 | Instant. nose, Non-delay tail | 754.4 | 092074 | Kawasaki Area | 6.0 sq mi destroyed and 1.48 sq mi or Yokohama destroyed. (D/A #47). |
| | | 181 | 23 May | 58th, 73rd, 313th, 314th | 520 | 10,000 | | | | E-36, #E46,<br>M-47 | Instant. nose, 7.5 sec to 23.8 sec tail | 3645.7 | 081063, 053062, 087088, 060086, 066038, 074112. | 90.17-Tokyo South Area | 3.2 sq mi destroyed (D/A #81). |
| | | 183 | 25 May | 58th, 73rd 313th, 314th | 464 | 15,000 | M-81 | | 4.0 | M36, E36,<br>E46, M17,<br>M75 | Instant to 28 sec nose Non-delay to 23.8 sec. tail | 3258.0 | 069040, 044046, 014049, 087058, 057064, 030070. | 90.17-Tokyo Palace Area | 18.6 sq mi destroyed (D/A #81). |
| | TOTALS | 7 | | | 1896 | | | | 160.34 | | | 11856.72 | | | Total destroyed 56.30 sq mi or 50.6% |
| | YOKOHAMA | 186 | 29 May | 58th, 73rd, 313th, 314th | 454 | 19,000 | | | | M47A2<br>M-69 | Instantaneous<br>Open 5000' over target | 2569.6 | 095072, 121060, 079053, 077110, 069082 | 90.17-Yokohama Area | Destroyed 8.90 sq mi or 44.0% Damaged nineteen (19) numbered targets (D/A #80). |
| 90.18 | NUMAZU | 271 | 15 July | 58th | 119 | 11,000 | | | | AN-M47A2<br>M17A1, E46 | Instant. nose<br>Open 5000' over target | 1035.8 | 071070 | 90.18-Numazu Urban Area | Destroyed 1.25 sq mi or 83.5% (D/A #146) |
| | SHIMIZU | 253 | 6 July | 313th | 133 | 7,500 | | | | AN-M47A2<br>AN-M17 | Instant. nose<br>Open 3000' over target | 1029.6 | 061097 | 90.18-Shimizu Urban Area | Destroyed 0.74 sq mi or 52.0% (D/A #132). |
| | SHIZUOKA | 212 | 19 June | 314th | 123 | 10,000 | | | | E-46<br>M-47 | Open 2500' over target<br>Instant. nose | 868.3 | 045106 | 90.18-2011 | Destroyed 2.28 sq mi or 66.0% Damaged one (1) numbered target (D/A #96). |
| 90.20 | GIFU | 260 | 9 July | 314th | 129 | 16,000 | | | | E-46<br>AN-M47A2 | Open 5000' over target<br>Instant. nose | 898.8 | 051062 | 90.20-Gifu Urban Area | Destroyed 1.93 sq mi or 74.0% (D/A #134). |
| | ICHINOMIYA | 264 | 12 July | 73rd | 123 | 9,000 | | | | AN-M47A2 | Instant. nose | 772 | 065087 | 90.20-Ichinomiya Urban Area | Destroyed .01 sq mi or 0.8% (D/A #136). |
| | | 299 | 28 July | 73rd | 122 | 15,000 | | | | M-47<br>M17, #E46 | Instant. nose<br>Open 5000' over target | 868.8 | 065087 | " " " | Destroyed 0.96 sq mi or 75% (F/A #375). |
| | TOTALS | 2 | | | 245 | | | | | | | 1640.8 | | | Total Destroyed 0.97 sq mi or 86.0% |
| | KUWANA | 273 | 16 July | 313th | 94 | 10,500 | | | | AN-M47A2<br>AN-M47A1 | Instant. nose<br>Open 5000' over target | 693.3 | 083082 | 90.20-Kuwana Urban Area | Destroyed 0.63 sq mi or 77.0% Damaged one (1) numbered target (D/A #152). |
| | NAGOYA | 41 | 11 Mar | 73rd, 313th, 314th | 280 | 7,000 | | | | E-46, M-47 | | 1789.8 | 079057, 105084, 052121 | 90.20-Nagoya Urban Area | 1.2 sq mi destroyed and 6 numbered targets, including 1729(D/A #18, 21). |
| | | 44 | 18 Mar | 73rd, 313th, 314th | 290 | 6,500 | | | | M47A2, M76, M64, M17A1, E46, T4E4, E36, E28 | Open 2-5000' over target. Some instant. nose, Non-delay tail | 1838.5 | 077093, 119085, 052121 | 90.20-Nagoya Urban Area | 2.95 sq mi destroyed Three numbered targets damaged, including 197 and 2010 (D/A #32). |
| | | 174 | 14 May | 73rd, 58th, 313th, 314th | 472 | 18,000 | | | | E46, E36 | 29.7 to 14.6 sec tail. No nose. | 2515.1 | 106107, 100118, 086126, 105093 | 90.20-Nagoya City Area | 3.15 sq mi destroyed including 24 numbered targets (D/A #77). |
| | | 176 | 16 May | 58th, 73rd, 313th, 314th | 457 | 11,000 | | | | M17, M47, E46 | 21 to 27 sec. tail, Instant. nose | 3609 | 091051, 081067, 090070, 084033 | 90.20-Nagoya City area | 1.82 sq mi destroyed including 74 numbered targets including damage to 131, 194, 197/241, 1729. (D/A #75, 77). |
| | TOTALS | 4 | | | 1499 | | | | | | | 9752.4 | | | Destroyed 17.17 sq mi or 11.8% |
| | OGAKI | 301 | 28 July | 314th | 90 | 15,000 | | | | M-47<br>E-46<br>M-17 | Instant. nose<br>Open 5000' over target<br>27 sec. nose | 668.7 | 044092 | 90.20-Ogaki Urban Area | Destroyed 0.54 sq mi or 18% (F/A #175). |
| | OKAZAKI | 280 | 19 July | 314th | 126 | 14,500 | | | | E-46, M17<br>M-47 | Open 5000' over target<br>Instant. nose | 850.0 | 044035 | 90.20-Okazaki Urban Area | Destroyed 0.65 sq mi or 64% (D/A #149). |
| | TOKKAICHI | 209 | 17 June | 313th | 89 | 7,500 | | | | M-17, E-46<br>M-47 | Open 5000' over target<br>Instant. nose | 567.3 | 060099 | 90.20-1684 | Destroyed 1.21 sq mi or 14% Damaged three (3) numbered targets, including 1684 (D/A #106). |
| 90.21 | HAMAMATSU | 208 | 17 June | 73rd | 130 | 8,500 | | | | M-17, E-46<br>M-47 | Open 5000' over target<br>Instant. nose | 911.7 | 076062 | 90.21-1219 | Destroyed 7.47 sq mi or 70% Damaged 4 numbered targets (Also attacked twice as secondary target). (D/A #101). |
| | TOYOHASHI | 210 | 19 June | 58th | 136 | 8,000 | | | | E-46, E-28<br>M-47 | Open 2500' over target<br>Instant. nose | 946.4 | 092084 | 90.21-1224 | Destroyed 1.70 sq mi or 53% Damaged one numbered target (12-4) D/A #126). |
| 90.22 | TSURUGA | 265 | 17 July | 313th | 92 | 13,000 | | | | AN-M47A2<br>E-46 | Instant. nose<br>Open 5000' over target | 679.1 | 103084 | 90.22-Tsuruga Urban Area | Destroyed 0.77 sq mi or 64% (D/A #152). |
| 90.24 | TSU | 286 | 24 July | 313th | 38 | 17,000 | M-64 | 1/100 nose | 280.3 | | | | 048058 | 90.24-2024 | |
| | | 289 | 24 July | 314th | 75 | 20,500 | M-56 | Instant. nose Non-delay tail | 298.0 | | | | 105074, 083082 | 90.24-Tsu Urban Area | Destroyed .217 sq mi total damage is .258 sq mi (F/A #359). |
| | | 297 | 28 July | 58th | 76 | 11,500 | | | | E-46 | Open 5000' over target | 546.5 | 051055 | 90.24-Tsu Urban Area | Destroyed .84 sq mi (F/A #175). |
| | TOTALS | 3 | | | 189 | | | | 578.3 | | | 546.5 | | | Destroyed 1.05 sq mi or 71.1% |
| | UJIYAMADA | 300 | 28 July | 313th | 93 | 13,000 | | | | E-46 | Open 5000' over target | 714.6 | 087047 | 90.24-Ujiyamada Urban Area | Destroyed 0.38 sq mi or 19% (F/A #412). |
| 90.25 | AKASHI | 292 | 5 July | 73rd | 123 | 7,500 | | | | E-46 | Open 2500' over target | 97.0 | 106061 | 90.25-1247-Akashi Area | Destroyed 0.90 sq mi or 61.5% (D/A #153). |
| | KOBE | 26 | 4 Feb | 73rd, 313th | 69 | 24,100 | | | 13.6 | | | 159.2 | 139137, 106136 079132, 074125 | 90.25-Kobe, Zone 1 of M-9 | Destroyed .09 sq mi Damaged three numbered targets. (D/A #6). |
| | | 43 | 16 Mar | 73rd, 313th, 314th | 307 | 7,500 | | | | M-76 | Instant. nose, M-9 tail | 2328.1 | 074139, 056123 | 90.25-Kobe Area | 2.9 sq mi destroyed including three numbered targets (D/A #6). |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NAGOYA | 41 | 11 Mar | 73rd,313th, 314th | 280 | 7,000 | | | | | E-46,M-47 | | 1789.8 | 075057, 105084, 052121 | 90.20-Nagoya Urban Area | 1.2 sq mi destroyed and 6 numbered targets, including 1729(D/A #18,21). |
| | | 44 | 18 Mar | 73rd, 313th, 314th | 290 | 6,500 | | | | | M47A2,M76, M64,M17A1, E46,T4E4, E36, E28 | Open 2-3000' over target. Some instant. nose, Non-delay tail | 1838.5 | 077093, 119089, 052121 | 90.20-Nagoya Urban Area | 2.95 sq mi destroyed Three numbered targets damaged, including 197 and 2010 (D/A #32). |
| | | 174 | 14 May | 73rd,58th, 313th, 314th | 472 | 18,000 | | | | | E46, E36 | 29.7 to 34.6 sec tail. No nose. | 2515.1 | 106107, 100118, 086126, 105093 | 90.20-Nagoya City Area | 3.15 sq mi destroyed including 2[illegible] numbered targets (D/A #77). |
| | | 176 | 16 May | 58th, 73rd, 313th, 314th | 457 | 11,000 | | | | | M17,M47, E46 | 21 to 27 sec. tail, instant. nose | 3609 | 091051, 081067, 090070, 088033 | 90.20-Nagoya City area | 1.82 sq mi destroyed including 74 numbered targets including damage to 131, 194, 197/241, 1729. (D/A #75, 77). |
| | TOTALS | 4 | | | 1499 | | | | | | | | 9752.4 | | | Destroyed 12.17 sq mi or 11.8% |
| | OGAKI | 301 | 28 July | 314th | 90 | 15,000 | | | | | M-47 E-46 M-17 | Instant. nose Open 5000' over target 27 sec. nose | 568.7 | 044092 | 90.20-Ogaki Urban Area | Destroyed 0.54 sq mi or 58% (F/R #375). |
| | OKAZAKI | 280 | 19 July | 314th | 126 | 14,500 | | | | | E-46, M17 M-47 | Open 5000' over target Instant. nose | 850.6 | 044035 | 90.20-Okazaki Urban Area | Destroyed 0.65 sq mi or 66% (D/A #149). |
| | TOYKAICHI | 209 | 17 June | 313th | 89 | 7,500 | | | | | M-17, E-46 M-47 | Open 5000' over target Instant. nose | 567.3 | 050099 | 90.20-1684 | Destroyed 1.21 sq mi or 36% Damaged three (3) numbered targets, including 1684 (D/A #106). |
| 90.21 | HAMAMATSU | 208 | 17 June | 73rd | 130 | 8,500 | | | | | M-17, E-46 M-47 | Open 5000' over target Instant. nose | 911.7 | 076062 | 90.21-1219 | Destroyed 2.97 sq mi or 70% Damaged 4 numbered targets (Also attacked twice as secondary target). (D/A #101). |
| | TOYOHASHI | 210 | 19 June | 58th | 136 | 8,000 | | | | | E-46, E-28 M-47 | Open 2500' over target Instant. nose | 945.4 | 049084 | 90.21-1224 | Destroyed 1.70 sq mi or 50% Damaged one numbered target (1774) D/A #126). |
| 90.22 | TSURUGA | 265 | 12 July | 313th | 92 | 13,000 | | | | | AN-M47A2 E-46 | Instant. nose Open 5000' over target | 679.1 | 103084 | 90.22-Tsuruga Urban Area | Destroyed 0.77 sq mi or 68% (D/A #162). |
| 90.24 | TSU | 288 | 24 July | 313th | 38 | 17,000 | M-64 | 1/100 nose | 280.3 | | | | | 044058 | 90.24-2224 | Destroyed .217 sq mi total damage is .258 sq mi (F/R #359). |
| | | 289 | 24 July | 314th | 75 | 20,500 | M-56 | Instant. nose Non-delay tail | 298.0 | | | | | 105074, 083082 | 90.24-Tsu Urban Area | |
| | | 297 | 28 July | 58th | 76 | 11,500 | | | | | E-46 | Open 5000' over target | 546.5 | 051055 | 90.24-Tsu Urban Area | Destroyed .84 sq mi (F/R #375). |
| | TOTALS | 3 | | | 189 | | | | 578.3 | | | | 546.5 | | | Destroyed 1.05 sq mi or 71.1% |
| | UJIYAMADA | 300 | 28 July | 313th | 93 | 13,000 | | | | | E-46 | Open 5000' over target | 771.6 | 087047 | 90.24-Ujiyamada Urban Area | Destroyed 0.16 sq mi or 19% (F/R #375). |
| 90.25 | AKASHI | 292 | 6 July | 73rd | 103 | 7,500 | | | | | E-46 | Open 2500' over target | 375.0 | 106051 | 90.25-1747-Akashi Area | Destroyed 0.90 sq mi or 43.5% (D/A #153). |
| | KOBE | 26 | 4 Feb | 73rd, 313th | 69 | 24,100 | | | 13.6 | | | | 159.2 | 139137, 106136 079132, 074125 | 90.25-Kobe, Zone 1 of M-9 | Destroyed .04 sq mi Damaged three numbered targets, (D/A #61). |
| | | 43 | 16 Mar | 73rd, 313th, 314th | 307 | 7,500 | | | | | M-76 E-46 M17A1,E36 T4E4 | Instant. nose,N-D tail Open 2500' over target Open 2000' over target Open 5000' below A/C | 2328.1 | 074139, 050123 095140, 095135 | 90.25-Kobe Area | 2.9 sq mi destroyed including three numbered targets (D/A #76). |
| | | 188 | 5 June | 58th, 73rd, 313th, 314th | 473 | 16,000 | | | | | E-46 T4E4 AN-M47 M-17 | N-D nose, Varied tail " " " " Instant. nose N-D tail 26 sec nose N-D tail | 3077.3 | 111137, 091110, 074090, 024024 | 90.25-Kobe Area "A" | 4.35 sq mi or 28% destroyed. Damaged/destroyed eighteen (18) numbered targets (D/A #96). |
| | TOTALS | 3 | | | 849 | | | | 13.6 | | | | 6664.6 | | | Destroyed 8.72 sq mi or 70.0% |
| | NISHINOMIYA MIKAGE | 314 | 5 Aug | 73rd, 314th | 248 | 13,350 | M-64 | Non-delay tail | 33.5 | | E-46, M-17 T4E4 M19 M47 | Open 5000' over target Open 3000' below A/C M19 tail M26 Al nose | 1819.9 | 111091, 042040 | 90.25-Nishinomiya Area | Destroyed 2.92 sq mi or 37.0% (F/R #401). |
| | OSAKA/ AMAGASAKI | 42 | 13 Mar | 73rd, 313th 314th | 275 | 7,000 | | | | | | | 1732.6 | 098122, 084083 090079 | 90.25-Osaka Area | 8.1 sq mi destroyed. Thirteen (13) numbered targets destroyed or damaged (D/A #24). |
| | | 187 | 1 June | 58th, 73rd, 313th, 314th | 456 | 24,000 | | | | | M-17 M-47 E-46 M-76 | 30.7 to 32.5 tail 31 sec. nose Instant. nose N-D tail 31.3 to 36.3 nose 36.5 sec. tail 14 to 15.2 tail 15.3 sec. nose | 2789.3 | 051072, 067054, 052091, 068105, 080115 | 90.25-Osaka Area | 3.15 sq mi destroyed, damaged seven (7) numbered targets (D/A #64). |
| | | 189 | 7 June | 58th, 73rd, 314th, 313th | 409 | 20,500 | | | | | E46,T4E4, E4F, M47 M65 M64 | Instant. nose Non-delay tail .01 sec nose & tail .01 sec. nose & tail | 1842.4 | 111106, 118082, 123087, 117124, 119113 | 90.25-Osaka Area | 2.21 sq mi destroyed, damaged four (4) numbered targets. (D/A #90). |
| | | 203 | 15 June | 58th, 73rd, 313th, 314th | 444 | 21,500 | | | | | M17, E46 M47 | Open 5000' over target Instant. nose | 3151.3 | 123077, 118082, 054126, 018110, | 90.25-Osaka Area | 2.49 sq mi destroyed, damaged nine (9) numbered targets, including 2674, 182, 2041 (66%). (D/A #99, 100). |
| | TOTALS | 4 | | | 1586 | | | | | | | | 9514.4 | | | Destroyed 16.44 sq mi or 37.0% |
| | SAKAI | 258 | 9 July | 73rd | 115 | 10,500 | | | | | AN-M47A2 E46, E46 | Instant. nose Open 5000' over target | 778.4 | 081079 | 90.25-Sakai Urban Area | Destroyed 0.99 sq mi or 42.5% (D/A #104). |
| | WAKAYAMA | 259 | 9 July | 313th | 108 | 11,000 | | | | | AN-M47A2 AN-17A1 | Instant. nose Open 5000' over target | 800.3 | 077102 | 90.25-Wakayama Urban Area | Destroyed 2.19 sq mi or 52.5% (D/A #145). |
| 90.27 | HIMEJI | 249 | 3 July | 313th | 106 | 11,000 | | | | | E-46 AN-M47 | Open 5000' over target Instant nose | 767.1 | 113097 | 90.27-Himeji-Hironata Area | Destroyed 1.48 sq mi or 76.7% (D/A #133). |
| | OKAYAMA | 234 | 28 June | 58th | 138 | 12,000 | | | | | M-47,M-69 | Instant. nose | 681.5 | 071097 | 90.27-Okayama Urban Area | Destroyed 2.11 sq mi or 63% (D/A #170). |
| | TAKAMATSU | 247 | 3 July | 58th | 116 | 10,500 | AN-M64 | Instant. nose | 24.3 | | #E-46 AN-M47 | Open 5000' over target Instant. nose | 808.8 | 060125 | 90.27-Takamatsu Urban Area | Destroyed 1.44 sq mi or 72% (D/A #136). |
| | TOKUSHIMA | 250 | 3 July | 314th | 129 | 13,500 | | | | | AN-M47 AN-M17 | Instant. nose Open 5000' over target | 1050.8 | 053063 | 90.27-Tokushima Urban Area | Destroyed 1.70 sq mi or 74.0% (D/A #117). |
| 90.28 | KOCHI | 248 | 3 July | 73rd | 125 | 11,000 | | | | | E-46 AN-M76 | Open 5000' over target Instant. nose,N-D tail | 1060.8 | 073094 | 90.28-Kochi Urban Area | Destroyed 0.92 sq mi or 48% (D/A #125). |
| 90.29 | FUKUYAMA | 321 | 8 Aug | 58th | 91 | 12,800 | | | | | M-47 M-17 | Instant. nose Open 5000' over target | 618.8 | 094097 | 90.29-Fukuyama Urban Area | Destroyed 0.88 sq mi or 73.3% (F/R #399). |
| | IMABARI | 316 | 5 Aug | 58th | 64 | 12,000 | M-64 | Proximity fuse | 8 | | E-46 M-26 | Open 5000' over target Open 3000' below A/C | 627.5 | 125114 | 90.29-Imabari Urban Area | Destroyed 0.71 sq mi or 76.0% (F/R #378). |
| | MATSUYAMA | 293 | 26 July | 73rd | 127 | 11,500 | | | | | M-47 E-46 | Instant. nose Open 5000' over target | 896.0 | 085052 | 90.29-MATSUYAMA Urban Area | Destroyed 1.22 sq mi or 73.0% (F/R #371). |
| 90.30 | KURE | 240 | 1 July | 58th | 152 | 11,000 | | | | | E-46 AN-M47A2 | Open 5000' over target Instant. nose | 1061.7 | 051088 | 90.30-Kure Urban Area | Destroyed 1.50 sq mi or 46.0% (F/R #318). |
| 90.31 | UWAJIMA | 266 | 12 July | 314th | 123 | 13,500 | | | | | AN-M47A2 E-46 | Instant. nose Open 5000' over target | 872.5 | 063062 | 90.31-Uwajima Urban Area | Destroyed .14 sq mi (F/R #348). |
| | | 302 | 28 July | 314th | 29 | 11,000 | | | | | M-47 E-47 | Instant. nose Open 5000' over target | 705.3 | 065079 | 90.31-Uwajima Urban area | Destroyed .35 sq mi (F/R #383). |
| | TOTALS | 2 | | | 152 | | | | | | | | 1577.8 | | | Destroyed .49 sq mi or 52% |
| 90.32 | TOKUYAMA | 294 | 26 July | 313th | 97 | 11,500 | T4E4 | Open 1000' below A/C | 33.4 | | M47, E46 | Instant. nose | 718.1 | 096045, 083045 | 90.32-Tokuyama Urban Area | Destroyed 0.68 sq mi or 53% (F/R #390). |
| | UBE | 242 | 1 July | 313th | 100 | 11,000 | | | | | AN-M47A2 E-46 | Instant. nose Open 5000' over target | 714.6 | 106104, 125067 | 90.32-Ube Urban Area | Destroyed 0.42 sq mi or 33% (D/A #118). |
| 90.33 | NOBEOKA | 237 | 28 June | 314th | 117 | 9,500 | | | | | AN-M47A2 E-46 | Instant. nose Open 5000' over target | 828.8 | 052069 | 90.33-Nobeoka Urban Area | Destroyed 0.52 sq mi or 38% (D/A #121). |
| | OITA | 272 | 15 July | 73rd | 124 | 10,500 | | | | | AN-M47A2 | Instant. nose | 790.4 | 058071 | 90.33-Oita Urban Area | Destroyed 0.56 sq mi or 26.2% (D/A #148). |
| 90.34 | MOJI | 236 | 28 June | 313th | 91 | 10,500 | | | | | AN-M47A2 E-46 | Instant. nose Open 4000' over target | 625.9 | 091130 | 90.34-Shimonoseki Urban Area | Destroyed 0.50 sq mi or 26.9% Damaged four (4) numbered targets (D/A #115). |
| | SHIMONOSEKI | 243 | 1 July | 314th | 126 | 13,000 | | | | | AN-M47A2 E-46 | Instant. nose Open 5000' over target | 833.0 | 035134 | 90.34-Shimonoseki Urban Area | Destroyed 0.51 sq mi or 38.0% Damaged two (2) numbered targets. (D/A #113). |
| | YAWATA | 319 | 8 Aug | 58th, 73rd, 313th | 210 | 20,000 | | | | | M17, E46 | Open 5000' over target | 1328.7 | 111035, 073035, 039037 | 90.34-Yawata Kokura Area | Destroyed 1.22 sq mi or 21.0% (F/R #398). |
| 90.35 | FUKUOKA/ HAKATA | 211 | 19 June | 73rd, 313th | 221 | 9,000 | | | | | E46, #E36 M-47 | Open 2500' over target Instant. nose | 1525.0 | 063018, 082039 | 90.35-Fukuoka Urban Area | Destroyed 1.37 sq mi or 21.5% (D/A #97). |
| | KUMAMOTO | 241 | 1 July | 73rd | 154 | 11,000 | | | | | AN-M47A2 E46,E36,48 | Instant. nose Open 5000' over target | 1113.2 | 081096, 051101 | 90.35-Kumamoto Urban Area | Destroyed 1.00 sq mi or 21.0% (D/A #122). |
| | OMUTA | 207 | 17 June | 58th | 116 | 8,000 | | | | | M-47 E-46 | Instant. nose Open 5000' over target | 769.2 | 081074 | 90.35-Omuta Urban area | Destroyed 0.217 sq mi damaged six (6) numbered targets (D/A #110). |
| | | 295 | 26 July | 314th | 124 | 14,500 | | | | | M-47 M-17 | Instant. nose Open 5000' over target | 964.6 | 081074 | 90.35-Omuta urban Area | Destroyed 2.05 sq mi (D/A #176). |
| | TOTALS | 2 | | | 240 | | | | | | | | 1733.8 | | | Destroyed 3.27 sq mi or 40% |
| | SAGA | 312 | 5 Aug | 58th | 63 | 12,000 | M-64 | Proximity fuse | 72 | | E-46 M-26 | Open 5000' over target Open 3000' below A/C | 566 | 082060 | 90.35-Saga Urban Area | No damage (F/R #398). |
| 90.36 | SASEBO | 235 | 28 June | 73rd | 141 | 11,000 | | | | | E46,M17 | Instant. nose,N-D tail | 1056.9 | 094117 | 90.36-Sasebo Urban Area | Destroyed 0.41 sq mi or 17.9% Damaged three (3) numbered targets. (D/A #129). |
| 90.36 | KAGOSHIMA | 206 | 17 June | 314th | 117 | 8,000 | | | | | M17, E46 M-47 | Open 5000' over target Instant. nose | 809.6 | 064083 | 90.36-Kagoshima Urban Area | Destroyed 2.15 sq mi or 40.1% Damaged two (2) numbered targets. (D/A #108). |
| | MIYAKONOJO | | | | 27 | | | | | | | | 158.0 | | | Sustained minor damage as secondary or last resort target. |

(Data compiled from 20AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Intelligence Reports, & Damage Assessment Reports.)

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# TABLE 2
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## AIRCRAFT INDUSTRY

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| Target No. & Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fuzing | Tons | I.B. BOMBS ON TARGET Type | Fuzing | Tons | Aiming Point W. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Dama... Flash Reports (F/R) as ind... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.13-1544 Nakajima A/C Company, Ota | 29 | 2-10-45 | 73rd & 313th Wings | 84 | 27,700' | | | 187 | | | 49.5 | 128133 | 90.13-1544 | 1,699,450 sq ft (74.6%) of plant roof ... |
| 90.13-1545 Nakajima A/C Company, Koizumi | 56 | 4-3-45 | 313th Wing | 45 | 7,575' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 275 | | | | 071024 | 90.13-1544 | 882,900 sq ft (23.8%) of plant roof ar... |
| 90.14-2145 Hitachi A/C Company, Chiba | 198 | 8-10-45 | 314th Wing | 28 | 16,500' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 138.2 | | | | 058087 | 90.14-2145 | Minor Damage to Plant (F/R #295) |
| 90.17-355 Nakajima A/C Company, Ogikubo | 199 | 8-10-45 | 314th Wing | 52 | 22,000' | AN-M 64 | 1/100 Nose, N.D. | 281.3 | | | | 143091 | 90.17-357 | Minor Damage to Plant (D/A #101) |
| | 323 | 8-10-45 | 314th Wing | 66 | 22,165' | GPs | Tail | | | | | 143091 | 90.17-357 | No Post-strike photos - Unobserved to ... |
| 90.17-357 Nakajima A/C Company, Musashino | 7 | 11-24-44 | 73rd Wing | 38 | 29,900' | M 64 GPs | | 194.2 | M 76 | | 65.3 | | | 16,058 sq ft destroyed/damaged -- Resul... |
| | 10 | 12-3-44 | 73rd Wing | 25 | 22,000' | T4 E4 | | 17.64 | M 18 | | 84.52 | | | Bombing by radar -- Damage negligible ... |
| | 16 | 12-27-44 | 73rd Wing | 50 | 31,300' | GPs | .10 nose,.025 tail | 40 | M 76 | Inst.Nose, N.D. tail | 69.3 | | | 3% of bombs within 1000' of Aiming Poi... |
| | 18 | 1-9-45 | 73rd Wing | 50 | 32,000' | GPs | | 42 | | | | | | 1% of bombs within 1000' of Aiming Poi... |
| | 51 | 4-1-45 | 73rd Wing | 115 | 6,895' | M 64 GPs | .01 nose,.025 tail .025 to 2 hr tail | 856.4 | | | | 034081 035086 | 90.17-357 | No visible damage from photo interpret... |
| | 58 | 4-7-45 | 73rd Wing | 101 | 13,575' | M 66 GPs | .1 nose, .025 tail | 490 | | | | 035086, 115013 | 90.17-357 | 36% of visible bursts within 1000' of ... half of plant (D/A #34) |
| | 65 | 4-12-45 | 73rd Wing | 94 | 14,675' | M 66 GPs | .025 nose,.025 tail | 490 | | | | 030086 | 90.17-357 | 48% of rf area destroyed/damaged by Mi... |
| | 320 | 8-7-45 | 314th Wing | 42 | 20,700' | M 66 GPs | 1/10 nose,.025 tail | 196 | | | | 030086 | 90.17-357 | No Post-strike photos -- Good to excel... |
| 90.17-732 Tachikawa A/C Company, Tachikawa | 57 | 4-3-45 | 73rd Wing | 61 | 6,450' | AN-M 64 GPs | .01 & no nose; N.D. to 1 hr delay tail | 490.1 | | | 12.7 | 038042 | 90.17-2009 | 307,000 sq ft (28.2%) of roof area des... |
| 90.17-1391/2200 Japan A/C Co., Tomioka | 196 | 8-10-45 | 58th Wing | 32 | 21,500' | AN-M 64 GPs | Inst. nose, N.D. tail | 172.5 | | | | 103115 | Tomioka Area | 247,900 sq ft (33%) of roof area destr... |
| 90.17-2008 Tachikawa Air Depot, Tachikawa | 126 | 4-30-45 | 73rd & 313th Wings | 106 | 21,500' | AN-M 64 GPs | .01 nose, N.D. tail | 614.5 | | | | 059038 | 90.17-2009 | Primary target hit by 7 A/C with poor ... |
| | 178 | 5-19-45 | 58th,313th,73rd & 314th Wings | 272 | 15,000' | AN-M 64 GPs | .01 nose, N.D. tail | 1486.0 | | | | 059038 069029 | 90.17-2009 | Hamamatsu hit as primary radar and 62 ... |
| | 200 | 6-10-45 | 314th Wing | 29 | 21,000' | M 64 GPs | 1/100 nose,N.D.tail | 163.5 | | | | 071027 | 90.17-2009 | 1,623,400 sq ft (38.5%) of rf area des... |
| 90.17-2009 Hitachi A/C Company, Tachikawa | 96 | 4-24-45 | 73rd,313th & 314th Wings | 101 | 12,000' | AN-M 64 GPs | 1/100 nose,N.D.tail | 535.8 | | | | 082070 | 90.17-2009 | Approx. 600,000 sq ft (59%) of rf area... |
| 90.18-2011 Shizuoka A/C Company, Shizuoka | 55 | 4-3-45 | 314th Wing | 48 | 7,940' | AN-M 64 GPs | .01 nose, N.D. tail | 176.2 | M 76 | Inst. Nose | 5.0 | 100079 | 90.18-2011 | 825,100 sq ft (48.8%) of roof area des... |
| 90.20-193 Mitsubishi A/C Co., Nagoya | 12 | 12-13-45 | 73rd Wing | 76 | 29,500' | GPs | .1 nose, 1/40 tail | 95 | E6 E2 | | 85.8 | | | 17.8% of roof area destroyed/damaged -... |
| | 14 | 12-22-45 | 73rd Wing | 51 | 30,700' | | | | M 76 | Inst.N,N.D. T. | 129.8 | | | Radar bombing -- no photography, resul... |
| | 22 | 1-23-45 | 73rd Wing | 60 | 26,250' | GPs | | 49 | | | 34 | | | Unsatisfactory results |
| | 34 | 2-15-45 | 73 & 313th Wgs | 33 | 30,000' | | | 90.5 | | | 33.7 | 123069,086064 | 90.20-193 | Approx. 5% of total roof area destroye... |
| | 45 | 3-24-45 | 73rd,313th & 314th Wings | 223 | 7,725' | M 64, M 81,M 26 | .01 nose, N.D. tail Inst. nose,N.D.tail | 1194.2 | M 76 M 74 | Inst.N,N.D. T. Open 3000' | 313.4 | 086064 123069 | 90.20-193 | 173,500 sq ft (4.9%) of rf area destr... of Nagoya destroyed & nearby Targets I... |
| | 48 | 3-30-45 | 314th Wing | 12 | 7,355' | M64 & 26 | .01 nose | 49.8 | | | | 123069 | 90.20-193 | Results poor -- no damage visible |
| | 59 | 4-7-45 | 313 & 314th Wgs | 153 | 20,500' | M 64 GPs | | 610.7 | | | | 086064,123069 | 90.20-193 | Results excellent and with previous da... Adjacent targets 196,197,254 (513,000 ... ally damaged by Mission 174 (Nagoya Ur... |
| 90.20-194 Mitsubishi A/C Co., Nagoya | 13 | 12-18-45 | 73rd Wing | 68 | 30,000' | GPs | .01 nose, .1 tail | 148.3 | | Inst.N,N.D. T. | 6.0 | | | 921,670 sq ft of rf area destroyed/dam... |
| | 19 | 1-14-45 | 73rd Wing | 60 | 30,500' | GPs | | 94.3 | | | | | | 13 and 19. 2,244,000 sq ft (39%) of r... 176 (Nagoya Urban) D/A #75. Tot. dama... |
| 90.20-198/2010 Aichi A/C Works, Nagoya | 193 | 6-8-45 | 313th Wing | 42 | 20,000' | M 56 GPS | Inst. nose, N.D.tail | 271.0 | | | | 075111 | 90.20-198 | 1,130,800 sq ft (95.7%) of rf area des... 34,000 sq ft destroyed by Mission 44 ( |
| 90.20-240 Kawasaki A/C Co., Kagamigahara | 219 | 6-22-45 | 313th Wing | 17 | 17,000' | M56 & 66 | Inst.nose, N.D. tail | 116.0 | | | | 079078 | 90.20-240 | 529,000 sq ft (33.5%) of rf area destr... |
| | 231 | 6-26-45 | 314th Wing | 25 | 22,000' | GPs | Inst.nose, N.D. tail | 143.0 | | | | 080078 | 90.20-240 | 953,700 sq ft (60.2%) of rf area destr... |
| 90.20-1635 Nakajima A/C Company, Handa | 290 | 7-24-45 | 314th Wing | 77 | 17,500' | M 64 GPs | 1/40 nose, N.D. tail | 537.3 | | | | 027121 | 90.20-1635 | 667,500 sq ft (44.2%) of rf area destr... |
| 90.20-1729 Aichi A/C Company, Nitoku | 229 | 6-26-45 | 313th Wing | 50 | 11,000' | GPs | 1/100 nose, N.D.tail | 346.0 | | | | 033063 | 90.20-194 | 175,700 sq ft of rf area (44.2%) destr... |
| | 287 | 7-24-45 | 313th Wing | 66 | 22,000' | M 66 GPs | Inst. nose,N.D. tail | 451.0 | | | | 033063 | 90.20-194 | 417,700 sq ft (16%) of rf area destroy... damage from Missions 41 & 174-176 is r... 131,500 sq ft (5%) from D/As 19 & 77. |
| 90.20-1855 Mitsubishi A/C Co., Kagamigahara | 218 | 6-22-45 | 313th Wing | 17 | 17,000' | M 56 | Inst. nose,N.D. tail | 90.0 | | | | 088070 | 90.20-240 | 75% of bombs fell within 1000' of aimi... |
| | 228 | 6-26-45 | 58th Wing | 60 | 16,000' | GPs | Inst. nose,N.D. tail | 411.5 | | | | 074068,089069 | 90.20-240 | Total damage fr Missions 218 & 228 is ... |
| 90.25-18 Kawanishi A/C Company, Naruo | 191 | 6-8-45 | 58th Wing | 44 | 20,500' | M 65 GPs | 1/1000 nose,N.D.tail | 263.5 | | | | 071031 | 90.25-18 | 1,807,250 sq ft (73.4%) of rf area des... |
| 90.25-1547 Kawasaki A/C Company, Akashi | 20 | 1-19-45 | 73rd Wing | 71 | 26,250' | GPs | | 152.5 | | | | | | Good Results--major damage to 38% of r... |
| | 220 | 6-22-45 | 313th Wing | 25 | 19,000' | M 56 | Inst.nose, N.D. tail | 148.0 | | | | 082046 | Akashi Area | 611,654 sq ft (13%) of rf area destroy... |
| | 225 | 6-26-45 | 313th Wing | 31 | 21,000' | LCs | Inst.nose, N.D. tail | 194.0 | | | | 081046 | Akashi Area | New damage 984,084 sq ft (20%) & total... |
| 90.25-1702 Kawanishi A/C Company, Fukae | 172 | 5-11-45 | 58th,73rd,313, & 314th Wings | 92 | 17,000' | M 64 GPs | .01 nose, N.D. tail | 459.6 | | | | 075027 | 90.25-1702 | 504,247 sq ft (39%) of roof area destr... |
| 90.25-2047 Kawanishi A/C Co., Himeji | 217 | 6-22-45 | 58th Wing | 52 | 16,500' | M 64 GPs | 1/100 nose, N.D.tail | 350.7 | | | | 133086,118079 | 90.27-2047 | 948,650 sq ft (99.5%) of roof area des... |
| 90.25-2137 Kawanishi A/C Co., Takarazuka | 285 | 7-24-45 | 58th Wing | 81 | 20,000' | M 65 GPs | 1/100 nose, N.D.tail | 474.5 | | | | 017137 | Takarazuka Area | 1,458,800 sq ft (85%) of roof area des... |
| 90.27-1691 Mitsubishi A/C Co., Tamashima | 216 | 6-22-45 | 314th Wing | 108 | 17,000' | M 64 GPs | 1/40 nose, N.D. tail | 602.8 | | | | 076045 | 90.27-1691 | 2,655,650 sq ft (87.5%) of roof area d... |
| 90.30-660/730/794 Hiro Naval A/C Co. Hiro Turbine Factory Hiro Naval Arsenal | 146 | 8-8-45 | 73rd & 58th Wings | 148 | 20,000' | M 65 & M 66 GPs | 100 sec nose,N.D. tail;.01 nose, N.D. tail | 610.1 | | | | 107069 103081 | 90.30-660 Kure | Target 660 sustained damage to extent... area; 1,261,125 sq ft (51.5%) of rf ar... damaged (D/A #61, 68). |
| 90.33-2080 Oita Naval Air Depot, Engine Section | 144 | 8-8-45 | 314th Wing | 17 | 17,250' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 105 | | | | | | 90% destroyed/damaged by Missions 144 ... |
| | 167 | 8-11-45 | 313th Wing | 17 | 13,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| 90.33-2081 Oita Naval Air Depot, A/F Section | 144 | 8-8-45 | 314th Wing | 17 | 17,250' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 105 | | | | | | Approximately 85% destroyed/damaged by... |
| | 167 | 8-11-45 | 313th Wing | 17 | 18,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| 90.36-1870 Tachiarai Machine Works, Tachiarai | 50 | 3-31-45 | 73rd & 314th Wings | 137 | 16,500' | M 64 GPs | Inst.Nose,.025 tail | 468.3 | | | | 095074 067064 | 90.36-1870 | Completely destroyed. (D/A #45) |
| 90.36-1627 Omura A/C Factory, Omura | 46 | 3-27-45 | 73rd & 314th Wings | 151 | 16,400' | M 64 GPs | | 475.3 | | | | 130023 | Omura A/F & 58 No. 849 | 544,025 sq ft of rf area (19.4%) destr... |

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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# TABLE 2
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## AIRCRAFT INDUSTRY

CONFIDENTIAL

| ding | A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fusing | Tons | I.B. BOMBS ON TARGET Type | Fusing | Tons | Aiming Point W. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Assessment Reports (D/A) and Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13th | 84 | 27,700' | | | 187 | | | 49.5 | 128133 | 90.13-1544 | 1,699,450 sq ft (74.6%) of plant roof area destroyed/damaged (D/A #7) |
| g | 43 | 7,575' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 275 | | | | 071024 | 90.13-1544 | 882,900 sq ft (23.8%) of plant roof area destroyed/damaged (D/A #44) |
| g | 26 | 16,500' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 158.2 | | | | 068087 | 90.14-2145 | Minor Damage to Plant (F/R #295) |
| g | 82 | 22,000' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 281.5 | | | | 143061 | 90.17-357 | Minor Damage to Plant (D/A #101) |
| g | 66 | 22,165' | | | | | | | 143091 | 90.17-357 | No Post-strike photos - Unobserved to Good |
| | 88 | 29,900' | M 64 GPs | | 194.2 | M 76 | | 63.5 | | | 16,058 sq ft destroyed/damaged -- Results poor |
| | 25 | 22,000' | T4 E4 | | 17.64 | M 18 | | 84.52 | | | Bombing by radar -- Damage negligible |
| | 50 | 31,300' | GPs | .10 nose,.025 tail | 40 | M 76 | Inst.Nose, N.D. tail | 69.3 | | | 3% of bombs within 1000' of Aiming Point - Results poor |
| | 50 | 32,000' | GPs | | 42 | | | | | | 1% of bombs within 1000' of Aiming Point - Results poor |
| | 115 | 6,895' | M 64 GPs | .01 nose,.025 tail .025 to 2 hr tail | 856.4 | | | | 034081 055086 | 90.17-357 | No visible damage from photo interpretation report (F/R #126) |
| | 101 | 13,575' | M 66 GPs | .1 nose, .025 tail | 490 | | | | 035086, 115013 | 90.17-357 | 36% of visible bursts within 1000' of AP--Considerable Damage in East half of plant (D/A #34) |
| | 94 | 14,675' | M 66 GPs | .025 nose,.025 tail | 490 | | | | 030086 | 90.17-357 | 48% of rf area destroyed/damaged by Missions 58 & 63, Total is 63% (D/A#39 |
| g | 42 | 20,700' | M 66 GPs | 1/10 nose,.025 tail | 196 | | | | 030086 | 90.17-357 | No Post-strike photos -- Good to excellent results |
| | 61 | 6,450' | AN-M 64 GPs | .01 & no nose; N.D. to 1 hr delay tail | 490.1 | | | 12.7 | 038042 | 90.17-2009 | 807,000 sq ft (28.2%) of roof area destroyed/damaged (D/A #35) |
| | 32 | 21,500' | AN-M 64 GPs | Inst. nose, N.D. tail | 172.5 | | | | 153115 | Tomioka Area | 247,900 sq ft (33%) of roof area destroyed/damaged (D/A #143) |
| 13th | 108 | 21,500' | AN-M 64 GPs | .01 nose, N.D. tail | 814.5 | | | | 059038 | 90.17-2009 | Primary target hit by 7 A/C with poor results -- no photos |
| ,73rd ings | 272 | 15,000' | AN-M 64 GPs | .01 nose, N.D. tai. | 1486.0 | | | | 059038 069029 | 90.17-2009 | Hamamatsu hit as primary radar and 62 acres burned out |
| g | 29 | 21,000' | M 64 GPs | 1/100 nose,N.D.tail | 163.5 | | | | 071027 | 90.17-2009 | 1,623,400 sq ft (38.5%) of rf area destroyed/damaged (D/A #131) |
| h & gs | 101 | 12,000' | AN-M 64 GPs | 1/100 nose,N.D.tail | 535.8 | | | | 092070 | 90.17-2009 | Approx. 600,000 sq ft (59%) of rf area destroyed/damaged (D/A #59) |
| g | 48 | 7,940' | AN-M 64 GPs | .01 nose, N.D. tail | 176.2 | M 76 | Inst. Nose | 5.0 | 100079 | 90.18-2011 | 823,100 sq ft (48.9%) of roof area destroyed/damaged (D/A #42) |
| | 78 | 29,500' | GPs | .1 nose, 1/40 tail | 95 | B6 R2 | | 85.8 | | | 17.8% of roof area destroyed/damaged -- Results good (D/A #5, 3 PR) |
| | 51 | 30,700' | | | | M 76 | Inst.N,N.D. T. | 129.8 | | | Radar bombing -- no photography, results unknown |
| | 60 | 26,250' | GPs | | 49 | | | 34 | | | Unsatisfactory results |
| Wgs | 33 | 30,000' | | | 90.5 | | | 33.7 | 123069,086064 | 90.20-193 | Approx. 5% of total roof area destroyed/damaged (D/A #22) |
| & gs | 223 | 7,725' | M 64, M 81,M 26 | .01 nose, N.D. tail Inst. nose,N.D.tail | 1194.2 | M 76 M 74 | Inst.N,N.D. T. Open 3000' | 313.4 | 086064 123069 | 90.20-193 | 173,500 sq ft (4.9%) of rf area destroyed/damaged; .28 sq mi of urban area of Nagoya destroyed & nearby Targets 196,200,254 extensively damaged.DA#27 |
| g | 12 | 7,355' | M64 & 26 | .01 nose | 49.8 | | | | 123069 | 90.20-193 | Results poor -- no damage visible |
| h Wgs | 153 | 20,500' | M 64 GPs | | 610.7 | | | | 086064,123069 | 90.20-193 | Results excellent and with previous damage, plant 94% destroyed (D/A #38) Adjacent targets 196,197,254 (513,000 sq ft) damage (D/A #46). Additionally damaged by Mission 174 (Nagoya Urban, D/A #77). |
| | 88 | 30,000' | GPs | .01 nose, .1 tail | 148.3 | | Inst.N,N.D. T. | 6.0 | | | 921,670 sq ft of rf area destroyed/damaged (D/A #1) result of Missions 13 and 19. 2,244,000 sq ft (39%) of rf area destroyed/damaged by Mission 176 (Nagoya Urban) D/A #75. Tot. damage & removal 3,380,795 sq ft (68.4%). |
| | 60 | 30,500' | GPs | | 94.3 | | | | | | |
| g | 42 | 20,000' | M 56 GPS | Inst. nose, N.D.tail | 271.0 | | | | 075111 | 90.20-198 | 1,130,800 sq ft (95.7%) of rf area destroyed/damaged (D/A #89 & 95). 34,000 sq ft destroyed by Mission 44 (Nagoya Urban) D/A #77. |
| g | 17 | 17,000' | M56 & 66 | Inst.nose, N.D. tail | 116.0 | | | | 079078 | 90.20-240 | 529,000 sq ft (33.5%) of rf area destroyed/damaged (D/A #109). |
| g | 25 | 22,000' | GPs | Inst.nose, N.D. tail | 143.0 | | | | 080078 | 90.20-240 | 953,700 sq ft (60.2%) of rf area destroyed/damaged (D/A #165). |
| g | 77 | 17,500' | M 64 GPs | 1/40 nose, N.D. tail | 537.3 | | | | 027121 | 90.20-1838 | 667,500 sq ft (44.2%) of rf area destroyed/damaged (D/A #188). |
| g | 50 | 11,000' | GPs | 1/100 nose, N.D.tail | 348.0 | | | | 033063 | 90.20-194 | 173,700 sq ft of rf area (44.2%) destroyed/damaged (D/A #124) |
| g | 66 | 22,000' | M 66 GPs | Inst. nose,N.D. tail | 451.0 | | | | 033063 | 90.20-194 | 417,700 sq ft (16%) of rf area destroyed/damaged (F/R #575); Additional damage from Missions 41 & 174-176 is respectively 394,860 sq ft (15%) & 131,500 sq ft (5%) from D/As 19 & 77. Tot. damage 1,117,000 sq ft (42%) |
| g | 17 | 17,000' | M 56 | Inst. nose,N.D. tail | 90.0 | | | | 088070 | 90.20-240 | 75% of bombs fell within 1000' of aiming point -- Results good D/A |
| | 60 | 16,000' | GPs | Inst. nose,N.D. tail | 411.5 | | | | 074068,089069 | 90.20-240 | Total damage fr Missions 218 & 228 is 227,000 sq ft (77.5%) destroyed.#144 |
| | 44 | 20,500' | M 66 GPs | 1/1000 nose,N.D.tail | 265.8 | | | | 071031 | 90.25-18 | 1,807,250 sq ft (73.4%) of rf area destroyed/damaged (D/A #91) |
| | 71 | 26,250' | GPs | | 152.5 | | | | | | Good Results--major damage to 38% of roof area (D/A #4) |
| g | 25 | 19,000' | M 56 | Inst.nose, N.D. tail | 148.0 | | | | 082046 | Akashi Area | 611,654 sq ft (18%) of rf area destroyed/damaged (D/A #104) D/A |
| g | 31 | 21,000' | LCs | Inst.nose, N.D. tail | 184.0 | | | | 081046 | Akashi Area | New damage 984,084 sq ft (29%) & total damage 2,511,450 sq ft (74.3%)#110. |
| ,513, ings | 92 | 17,000' | M 64 GPs | .01 nose, N.D. tail | 459.5 | | | | 075027 | 90.25-1702 | 504,247 sq ft (39%) of roof area destroyed/damaged (D/A #79) |
| | 52 | 16,500' | M 64 GPs | 1/100 nose, N.D.tail | 350.7 | | | | 133086,118079 | 90.27-2047 | 948,650 sq ft (99.0%) of roof area destroyed/damaged (D/A #103) |
| | 81 | 20,000' | M 66 GPs | 1/100 nose, N.D.tail | 474.5 | | | | 017137 | Takarazuka Area | 1,488,900 sq ft (88%) of roof area destroyed/damaged (D/A #158) |
| g | 108 | 17,000' | M 64 GPs | 1/40 nose, N.D. tail | 602.5 | | | | 076043 | 90.27-1681 | 2,855,650 sq ft (87.5%) of roof area destroyed/damaged (D/A #106) |
| th | 148 | 20,000' | M 65 & M 66 GPs | 100 sec nose,N.D. tail;.01 nose, N.D. tail | 610.1 | | | | 107069 108081 | 90.30-660 Kure | Target 660 sustained damage to extent of 779,457 sq ft (71.5%) of roof area; 1,261,125 sq ft (51.5%) of rf area of other two plants destroyed/ damaged (D/A #61, 68). |
| | 17 | 17,000' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 108 | | | | | | 90% destroyed/damaged by Missions 144 & 187 (D/A #94) |
| | 17 | 13,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| | 17 | 17,000' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 108 | | | | | | Approximately 85% destroyed/damaged by Missions 144 & 187 (D/A #94) |
| | 17 | 13,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| th | 137 | 18,500' | M 64 GPs | Inst.Nose,.025 tail | 488.3 | | | | 060074 067064 | 90.36-1370 | Completely destroyed. (D/A #45) |
| th | 181 | 16,400' | M 64 GPs | | 475.3 | | | | 130025 | Omura A/F & Ss No. 849 | 544,025 sq ft of rf area (19.4%) destroyed/damaged (D/A #50) |

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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| Target No. & Name | Mission No. | Date | Units | Target | Altitude | Type | Fuzing | Tons | Type | Fuzing | Tons | M. P. I. | 20th AF Litho Mosaic | Flash Reports (F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.13-1544 Nakajima A/C Company, Ota | 29 | 2-10-45 | 73rd & 313th Wings | 84 | 27,700' | | | 187 | | | 49.5 | 123133 | 90.13-1544 | 1,699,450 sq ft (74.6%) of p |
| 90.13-1545 Nakajima A/C Company, Koizumi | 56 | 4-3-45 | 313th Wing | 43 | 7,575' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 275 | | | | 071024 | 90.13-1544 | 882,900 sq ft (23.8%) of pl |
| 90.14-2145 Hitachi A/C Company, Chiba | 198 | 6-10-45 | 314th Wing | 26 | 16,500' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 138.2 | | | | 069037 | 90.14-2145 | Minor Damage to Plant (P/R # |
| 90.17-356 Nakajima A/C Company, Ogikubo | 199 | 6-10-45 | 314th Wing | 52 | 22,000' | AN-M 64 | 1/100 Nose, N.D. | 281.3 | | | | 143091 | 90.17-357 | Minor Damage to Plant (D/A # |
| | 325 | 8-10-45 | 314th Wing | 66 | 22,165' | GPs | Tail | | | | | 143091 | 90.17-357 | No Post-strike photos - Unob |
| 90.17-357 Nakajima A/C Company, Musashino | 7 | 11-24-44 | 73rd Wing | 88 | 29,900' | M 64 GPs | | 194.2 | M 76 | | 83.3 | | | 18,058 sq ft destroyed/damag |
| | 10 | 12-3-44 | 73rd Wing | 25 | 22,000' | T4 E4 | | 17.64 | M 18 | | 84.52 | | | Bombing by radar -- Damage m |
| | 16 | 12-27-44 | 73rd Wing | 50 | 31,300' | GPs | .10 nose,.025 tail | 40 | M 76 | Inst.Nose, N.D. tail | 69.3 | | | 3% of bombs within 1000' of |
| | 18 | 1-9-45 | 73rd Wing | 50 | 32,000' | GPs | | 42 | | | | | | 1% of bombs within 1000' of |
| | 51 | 4-1-45 | 73rd Wing | 115 | 6,895' | M 64 GPs | .01 nose,.025 tail .025 to 2 hr tail | 856.4 | | | | 034081 035086 | 90.17-357 | No visible damage from photo |
| | 58 | 4-7-45 | 73rd Wing | 101 | 13,575' | M 66 GPs | .1 nose, .025 tail | 490 | | | | 035086, 115013 | 90.17-357 | 36% of visible bursts within half of plant (D/A #34) |
| | 63 | 4-12-45 | 73rd Wing | 94 | 14,675' | M 66 GPs | .025 nose,.025 tail | 490 | | | | 030086 | 90.17-357 | 48% of rf area destroyed/dam |
| | 320 | 8-7-45 | 314th Wing | 42 | 20,700' | M 66 GPs | 1/10 nose,.025 tail | 196 | | | | 030086 | 90.17-357 | No Post-strike photos -- Goo |
| 90.17-792 Tachikawa A/C Company, Tachikawa | 57 | 4-3-45 | 73rd Wing | 61 | 6,450' | AN-M 64 GPs | .01 & no nose; N.D. to 1 hr delay tail | 490.1 | | | 12.7 | 038042 | 90.17-2009 | 807,000 sq ft (28.2%) of ro |
| 90.17-1391/2200 Japan A/C Co., Tomioka | 196 | 6-10-45 | 58th Wing | 32 | 21,500' | AN-M 64 GPs | Inst. nose, N.D. tail | 172.5 | | | | 103115 | Tomioka Area | 247,900 sq ft (33%) of roof |
| 90.17-2008 Tachikawa Air Depot, Tachikawa | 126 | 4-30-45 | 73rd & 313th Wings | 106 | 21,500' | AN-M 64 GPs | .01 nose, N.D. tail | 614.5 | | | | 059038 | 90.17-2009 | Primary target hit by 7 A/C |
| | 178 | 5-19-45 | 58th,313th,73rd & 314th Wings | 272 | 15,000' | AN-M 64 GPs | .01 nose, N.D. tail | 1486.0 | | | | 059038 069029 | 90.17-2009 | Hamamatsu hit as primary re |
| | 200 | 6-10-45 | 314th Wing | 29 | 21,000' | M 64 GPs | 1/100 nose,N.D.tail | 163.5 | | | | 071027 | 90.17-2009 | 1,623,400 sq ft (38.5%) of r |
| 90.17-2009 Hitachi A/C Company, Tachikawa | 96 | 4-24-45 | 73rd,313th & 314th Wings | 101 | 12,000' | AN-M 64 GPs | 1/100 nose,N.D.tail | 535.8 | | | | 092070 | 90.17-2009 | Approx. 600,000 sq ft (59%) |
| 90.18-2011 Shizuoka A/C Company, Shizuoka | 55 | 4-3-45 | 314th Wing | 48 | 7,940' | AN-M 64 GPs | .01 nose, N.D. tail | 176.2 | M 76 | Inst. Nose | 5.0 | 100079 | 90.18-2011 | 823,100 sq ft (48.9%) of roo |
| 90.20-193 Mitsubishi A/C Co., Nagoya | 12 | 12-13-45 | 73rd Wing | 76 | 29,500' | GPs | .1 nose, 1/40 tail | 95 | E6 R2 | | 85.8 | | | 17.8% of roof area destroye |
| | 14 | 12-22-45 | 73rd Wing | 51 | 30,700' | | | | M 76 | Inst.N,N.D. T. | 129.8 | | | Radar bombing -- no photogra |
| | 22 | 1-23-45 | 73rd Wing | 60 | 26,250' | GPs | | 49 | | | 34 | | | Unsatisfactory results |
| | 34 | 2-15-45 | 73 & 313th Wgs | 33 | 30,000' | | | 90.5 | | | 33.7 | 123069,086064 | 90.20-193 | Approx. 5% of total roof are |
| | 45 | 3-24-45 | 73rd,313th & 314th Wings | 223 | 7,725' | M 64, M 81,M 26 | .01 nose, N.D. tail Inst. nose,N.D.tail | 1194.2 | M 76 M 74 | Inst.N,N.D. T. Open 3000' | 313.4 | 086064 123069 | 90.20-193 | 173,500 sq ft (4.9%) of rf of Nagoya destroyed & nearby |
| | 48 | 3-30-45 | 314th Wing | 12 | 7,355' | M64 & 26 | .01 nose | 49.8 | | | | 123069 | 90.20-193 | Results poor -- no damage vi |
| | 59 | 4-7-45 | 313 & 314th Wgs | 153 | 20,500' | M 64 GPs | | 610.7 | | | | 086064,123069 | 90.20-193 | Results excellent and with Adjacent targets 196,197,25 ally damaged by Mission 174 |
| 90.20-194 Mitsubishi A/C Co., Nagoya | 13 | 12-18-45 | 73rd Wing | 88 | 30,000' | GPs | .01 nose, .1 tail | 148.3 | | Inst.N,N.D. T. | 6.0 | | | 921,670 sq ft of rf area de |
| | 19 | 1-14-45 | 73rd Wing | 60 | 30,500' | GPs | | 94.3 | | | | | | 13 and 19. 2,244,000 sq ft |
| | | | | | | | | | | | | | | 176 (Nagoya Urban) D/A #75. |
| 90.20-198/2010 Aichi A/C Works, Nagoya | 193 | 6-9-45 | 313th Wing | 42 | 20,000' | M 66 GPs | Inst. nose, N.D.tail | 271.0 | | | | 075111 | 90.20-198 | 1,130,800 sq ft (95.7%) of 34,000 sq ft destroyed by M |
| 90.20-240 Kawasaki A/C Co., Kagamigahara | 219 | 6-22-45 | 313th Wing | 17 | 17,000' | M56 & 66 | Inst.nose, N.D. tail | 116.0 | | | | 079078 | 90.20-240 | 529,000 sq ft (33.8%) of rf |
| | 231 | 6-26-45 | 314 th Wing | 25 | 22,000' | GPs | Inst.nose, N.D. tail | 143.0 | | | | 080078 | 90.20-240 | 953,700 sq ft (60.2%) of rf |
| 90.20-1635 Nakajima A/C Company, Handa | 290 | 7-24-45 | 314th Wing | 77 | 17,500' | M 64 GPs | 1/40 nose, N.D. tail | 537.3 | | | | 027121 | 90.20-1635 | 687,500 sq ft (44.2%) of rf |
| 90.20-1729 Aichi A/C Company, Eitoku | 229 | 6-26-45 | 313th Wing | 50 | 11,000' | GPs | 1/100 nose, N.D.tail | 348.0 | | | | 033063 | 90.20-194 | 173,700 sq ft of rf area (4 |
| | 287 | 7-24-45 | 313th Wing | 66 | 22,000' | M 66 GPs | Inst. nose,N.D. tail | 451.0 | | | | 033063 | 90.20-194 | 417,700 sq ft (16%) of rf ar damage from Missions 41 & 1 |
| | | | | | | | | | | | | | | 131,500 sq ft (5%) from D/A |
| 90.20-1833 Mitsubishi A/C Co., Kagamigahara | 218 | 6-22-45 | 313th Wing | 17 | 17,000' | M 56 | Inst. nose,N.D. tail | 90.0 | | | | 088070 | 90.20-240 | 75% of bombs fell within 10 |
| | 228 | 6-26-45 | 58th Wing | 60 | 16,000' | GPs | Inst. nose,N.D. tail | 411.5 | | | | 074068,089069 | 90.20-240 | Total damage fr Missions 21 |
| 90.25-18 Kawanishi A/C Company, Naruo | 191 | 6-9-45 | 58th Wing | 44 | 20,500' | M 65 GPs | 1/1000 nose,N.D.tail | 263.5 | | | | 071031 | 90.25-18 | 1,807,250 sq ft (73.4%) of r |
| 90.25-1547 Kawasaki A/C Company, Akashi | 20 | 1-19-45 | 73rd Wing | 71 | 26,250' | GPs | | 152.5 | | | | | | Good Results--major damage |
| | 220 | 6-22-45 | 313th Wing | 25 | 19,000' | M 56 | Inst.nose, N.D. tail | 148.0 | | | | 082046 | Akashi Area | 611,654 sq ft (18%) of rf ar |
| | 225 | 6-26-45 | 313th Wing | 31 | 21,000' | LCs | Inst.nose, N.D. tail | 194.0 | | | | 081046 | Akashi Area | New damage 984,084 sq ft (2 |
| 90.25-1702 Kawanishi A/C Company, Fukae | 172 | 5-11-45 | 58th,73rd,313, & 314th Wings | 92 | 17,000' | M 64 GPs | .01 nose, N.D. tail | 459.5 | | | | 075027 | 90.25-1702 | 504,247 sq ft (39%) of roof |
| 90.25-2047 Kawanishi A/C Co., Himeji | 217 | 6-22-45 | 58th Wing | 52 | 16,500' | M 64 GPs | 1/100 nose, N.D.tail | 350.7 | | | | 133086,118079 | 90.27-2047 | 948,650 sq ft (99.0%) of ro |
| 90.25-2137 Kawanishi A/C Co., Takarazuka | 285 | 7-24-45 | 58th Wing | 81 | 20,000' | M 65 GPs | 1/100 nose, N.D.tail | 474.5 | | | | 017137 | Takarazuka Area | 1,488,300 sq ft (85%) of ro |
| 90.27-1691 Mitsubishi A/C Co., Tamashima | 216 | 6-22-45 | 314th Wing | 108 | 17,000' | M 64 GPs | 1/40 nose, N.D. tail | 602.8 | | | | 076043 | 90.27-1691 | 2,655,650 sq ft (87.5%) of r |
| 90.30-550/730/794 Hiro Naval A/C Co. Hiro Turbine Factory Hiro Naval Arsenal | 146 | 5-5-45 | 73rd & 58th Wings | 148 | 20,000' | M 65 & M 66 GPs | 100 sec nose,N.D. tail;.01 nose, N.D. tail | 610.1 | | | | 107069 108081 | 90.30-550 Kure | Target 550 sustained damage area; 1,251,125 sq ft (51.5% damaged (D/A #61, 68). |
| 90.33-2080 Oita Naval Air Depot, Engine Section | 144 | 5-5-45 | 314th Wing | 17 | 17,200' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 105 | | | | | | 90% destroyed/damaged by Mi |
| | 167 | 5-11-45 | 313th Wing | 17 | 13,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| 90.33-2081 Oita Naval Air Depot, A/F Section | 144 | 5-5-45 | 314th Wing | 17 | 17,200' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 105 | | | | | | Approximately 85% destroyed |
| | 167 | 5-11-45 | 313th Wing | 17 | 18,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| 90.36-1370 Tachiarai Machine Works, Tachiarai | 50 | 3-31-45 | 73rd & 314th Wings | 137 | 16,500' | M 64 GPs | Inst.Nose,.025 tail | 488.3 | | | | 095074 067064 | 90.36-1370 | Completely destroyed. (D/A |
| 90.36-1627 Omura A/C Factory, Omura | 46 | 3-27-45 | 73rd & 314th Wings | 151 | 16,400' | M 64 GPs | | 475.3 | | | | 130025 | Omura A/F & SS No. 849 | 544,025 sq ft of rf area (1 |

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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| | Target | Altitude | Type | Fusing | Tons | Type | Fusing | Tons | W. P. I. | 20th AF Litho Mosaic | Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| th | 84 | 27,700' | | | 187 | | | 49.5 | 128153 | 90.13-1544 | 1,899,450 sq ft (74.6%) of plant roof area destroyed/damaged (D/A #47) |
| | 43 | 7,575' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 275 | | | | 071024 | 90.13-1544 | 882,900 sq ft (23.8%) of plant roof area destroyed/damaged (D/A #44) |
| | 26 | 16,500' | AN-M 64 GPs | 1/100 Nose, N.D. Tail | 138.2 | | | | 058037 | 90.14-2145 | Minor Damage to Plant (F/R #296) |
| | 52 | 22,000' | AN-M 64 | 1/100 Nose, N.D. | 261.3 | | | | 143091 | 90.17-357 | Minor Damage to Plant (D/A #101) |
| | 66 | 22,165' | GPs | Tail | | | | | 143091 | 90.17-357 | No Post-strike photos - Unobserved to Good |
| | 88 | 29,900' | M 64 GPs | | 194.2 | M 76 | | 85.3 | | | 16,058 sq ft destroyed/damaged -- Results poor |
| | 25 | 22,000' | T4 E4 | | 17.64 | M 18 | | 84.52 | | | Bombing by radar -- Damage negligible |
| | 50 | 31,300' | GPs | .10 nose,.025 tail | 40 | M 76 | Inst.Nose, N.D. tail | 69.3 | | | 3% of bombs within 1000' of Aiming Point - Results poor |
| | 50 | 32,000' | GPs | | 42 | | | | | | 1% of bombs within 1000' of Aiming Point - Results poor |
| | 115 | 6,895' | M 64 GPs | .01 nose,.025 tail .025 to 2 hr tail | 856.4 | | | | 034081 035086 | 90.17-357 | No visible damage from photo interpretation report (F/R #128) |
| | 101 | 13,575' | M 66 GPs | .1 nose, .025 tail | 490 | | | | 035086, 115013 | 90.17-357 | 36% of visible bursts within 1000' of AP--Considerable Damage in East half of plant (D/A #34) |
| | 94 | 14,675' | M 66 GPs | .025 nose,.025 tail | 490 | | | | 030086 | 90.17-357 | 48% of rf area destroyed/damaged by Missions 58 & 63, Total is 63% (D/A#59 |
| | 42 | 20,700' | M 66 GPs | 1/10 nose,.025 tail | 196 | | | | 030086 | 90.17-357 | No Post-strike photos -- Good to excellent results |
| | 61 | 6,450' | AN-M 64 GPs | .01 & no nose; N.D. to 1 hr delay tail | 490.1 | | | 12.7 | 038042 | 90.17-2009 | 307,000 sq ft (28.2%) of roof area destroyed/damaged (D/A #35) |
| | 32 | 21,500' | AN-M 64 GPs | Inst. nose, N.D. tail | 172.5 | | | | 103116 | Tomioka Area | 247,900 sq ft (33%) of roof area destroyed/damaged (D/A #143) |
| th | 106 | 21,500' | AN-M 64 GPs | .01 nose, N.D. tail | 814.5 | | | | 059038 | 90.17-2009 | Primary target hit by 7 A/C with poor results -- no photos |
| 73rd | 272 | 15,000' | AN-M 64 GPs | .01 nose, N.D. tail | 1486.0 | | | | 059038 069029 | 90.17-2009 | Hamamatsu hit as primary radar and 62 acres burned out |
| | 29 | 21,000' | M 64 GPs | 1/100 nose,N.D.tail | 163.5 | | | | 071027 | 90.17-2009 | 1,623,400 sq ft (38.5%) of rf area destroyed/damaged (D/A #131) |
| & | 101 | 12,000' | AN-M 64 GPs | 1/100 nose,N.D.tail | 555.8 | | | | 092070 | 90.17-2009 | Approx. 600,000 sq ft (59%) of rf area destroyed/damaged (D/A #69) |
| | 48 | 7,940' | AN-M 64 GPs | .01 nose, N.D. tail | 176.2 | M 76 | Inst. Nose | 5.0 | 100079 | 90.18-2011 | 823,100 sq ft (48.9%) of roof area destroyed/damaged (D/A #42) |
| | 76 | 29,800' | GPs | .1 nose, 1/40 tail | 98 | E6 M2 | | 85.8 | | | 17.8% of roof area destroyed/damaged -- Results good (D/A #3, 3 PR) |
| | 51 | 30,700' | | | | M 76 | Inst.N,N.D. T. | 129.8 | | | Radar bombing -- no photography, results unknown |
| | 60 | 26,250' | GPs | | 49 | | | 34 | | | Unsatisfactory results |
| Wgs | 33 | 30,000' | | | 90.5 | | | 33.7 | 123069,086064 | 90.20-193 | Approx. 5% of total roof area destroyed/damaged (D/A #22) |
| & | 223 | 7,725' | M 64, M 81,M 26 | .01 nose, N.D. tail Inst. nose,N.D.tail | 1154.2 | M 76 M 74 | Inst.N,N.D. T. Open 3000' | 313.4 | 086064 123069 | 90.20-193 | 173,500 sq ft (4.9%) of rf area destroyed/damaged; .28 sq mi of urban area of Nagoya destroyed & nearby Targets 196,200,254 extensively damaged.DA#27 |
| | 12 | 7,355' | M64 & 26 | .01 nose | 49.8 | | | | 123069 | 90.20-193 | Results poor -- no damage visible |
| Wgs | 153 | 20,500' | M 64 GPs | | 610.7 | | | | 086064,123069 | 90.20-193 | Results excellent and with previous damage, plant 94% destroyed (D/A #38) Adjacent targets 196,197,254 (513,000 sq ft) damage (D/A #46). Additionally damaged by Mission 174 (Nagoya Urban, D/A #77). |
| | 68 | 30,000' | GPs | .01 nose, .1 tail | 148.3 | | Inst.N,N.D. T. | 6.0 | | | 921,670 sq ft of rf area destroyed/damaged (D/A #1) result of Missions 13 and 19. 2,244,000 sq ft (59%) of rf area destroyed/damaged by Mission 176 (Nagoya Urban) D/A #75. Tot. damage & removal 3,880,795 sq ft (68.4%). |
| | 60 | 30,500' | GPs | | 94.3 | | | | | | |
| | 42 | 20,000' | M 56 GPS | Inst. nose, N.D.tail | 271.0 | | | | 075111 | 90.20-198 | 1,130,800 sq ft (95.7%) of rf area destroyed/damaged (D/A #89 & 95). 34,000 sq ft destroyed by Mission 44 (Nagoya Urban) D/A #77. |
| | 17 | 17,000' | M56 & 66 | Inst.nose, N.D. tail | 116.0 | | | | 079078 | 90.20-240 | 529,000 sq ft (33.5%) of rf area destroyed/damaged (D/A #109). |
| | 25 | 22,000' | GPs | Inst.nose, N.D. tail | 143.0 | | | | 080078 | 90.20-240 | 955,700 sq ft (60.2%) of rf area destroyed/damaged (D/A #165). |
| | 77 | 17,500' | M 64 GPs | 1/40 nose, N.D. tail | 537.3 | | | | 027121 | 90.20-1635 | 667,500 sq ft (44.2%) of rf area destroyed/damaged (D/A #165). |
| | 50 | 11,000' | GPs | 1/100 nose, N.D.tail | 346.0 | | | | 033063 | 90.20-194 | 175,700 sq ft of rf area (44.2%) destroyed/damaged (D/A #124) |
| | 66 | 22,000' | M 66 GPs | Inst. nose,N.D. tail | 451.0 | | | | 033063 | 90.20-194 | 417,700 sq ft (16%) of rf area destroyed/damaged (F/R #575); Additional damage from Missions 41 & 174-176 is respectively 394,660 sq ft (15%) & 131,500 sq ft (5%) from D/As 19 & 77. Tot. damage 1,117,000 sq ft (42%) |
| | 17 | 17,000' | M 56 | Inst. nose,N.D. tail | 90.0 | | | | 088070 | 90.20-240 | 75% of bombs fell within 1000' of aiming point -- Results good D/A |
| | 60 | 16,000' | GPs | Inst. nose,N.D. tail | 411.5 | | | | 074068,089069 | 90.20-240 | Total damage fr Missions 218 & 228 is 227,000 sq ft (77.8%) destroyed.#144 |
| | 44 | 20,500' | M 65 GPs | 1/1000 nose,N.D.tail | 263.5 | | | | 071031 | 90.25-18 | 1,807,250 sq ft (73.4%) of rf area destroyed/damaged (D/A #91) |
| | 71 | 26,250' | GPs | | 152.5 | | | | | | Good Results--major damage to 58% of roof area (D/A #4) |
| | 25 | 19,000' | M 56 | Inst.nose, N.D. tail | 148.0 | | | | 082046 | Akashi Area | 611,654 sq ft (18%) of rf area destroyed/damaged (D/A #104) D/A |
| | 31 | 21,000' | LCs | Inst.nose, N.D. tail | 184.0 | | | | 081046 | Akashi Area | New damage 984,084 sq ft (29%) & total damage 2,511,450 sq ft (74.3%)#110. |
| 13, gs | 92 | 17,000' | M 64 GPs | .01 nose, N.D. tail | 459.5 | | | | 075027 | 90.25-1702 | 504,247 sq ft (39%) of roof area destroyed/damaged (D/A #79) |
| | 52 | 16,500' | M 64 GPs | 1/100 nose, N.D.tail | 350.7 | | | | 133036,118079 | 90.27-2047 | 948,550 sq ft (99.0%) of roof area destroyed/damaged (D/A #102) |
| | 81 | 20,000' | M 65 GPs | 1/100 nose, N.D.tail | 474.5 | | | | 017137 | Takarazuka Area | 1,488,800 sq ft (85%) of roof area destroyed/damaged (D/A #158) |
| | 108 | 17,000' | M 64 GPs | 1/40 nose, N.D. tail | 602.8 | | | | 076043 | 90.27-1631 | 2,855,550 sq ft (87.5%) of roof area destroyed/damaged (D/A #105) |
| | 148 | 20,000' | M 65 & M 66 GPs | 100 sec nose,N.D. tail;.01 nose, N.D. tail | 610.1 | | | | 107069 108081 | 90.30-880 Kure | Target 880 sustained damage to extent of 779,457 sq ft (71.5%) of roof area; 1,261,125 sq ft (51.5%) of rf area of other two plants destroyed/ damaged (D/A #61, 68). |
| | 17 | 17,200' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 105 | | | | | | 90% destroyed/damaged by Missions 144 & 167 (D/A #94) |
| | 17 | 13,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| | 17 | 17,200' | M 64 GPs | Inst. to no nose,N.D. nose to 1-24 hr del. | 105 | | | | | | Approximately 85% destroyed/damaged by Missions 144 & 167 (D/A #94) |
| | 17 | 18,750' | M65 & 66 | .01 nose, N.D. tail | 86 | | | | | | |
| | 137 | 15,300' | M 64 GPs | Inst.Nose,.025 tail | 488.3 | | | | 095074 067064 | 90.35-1370 | Completely destroyed. (D/A #45) |
| | 151 | 16,400' | M 64 GPs | | 475.3 | | | | 130023 | Omura A/F & SS No. 849 | 544,025 sq ft of rf area (19.4%) destroyed/damaged (D/A #80) |

ata compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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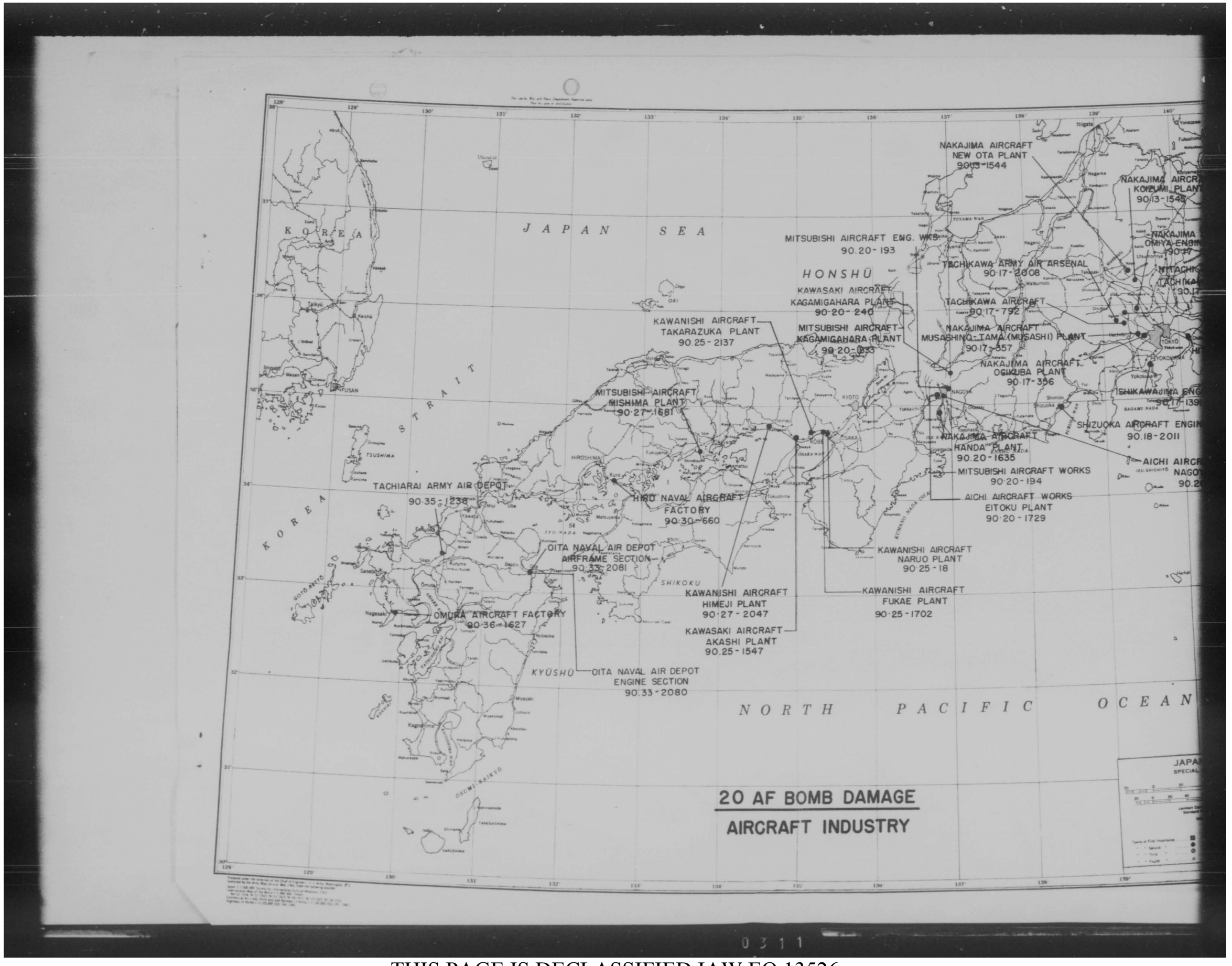


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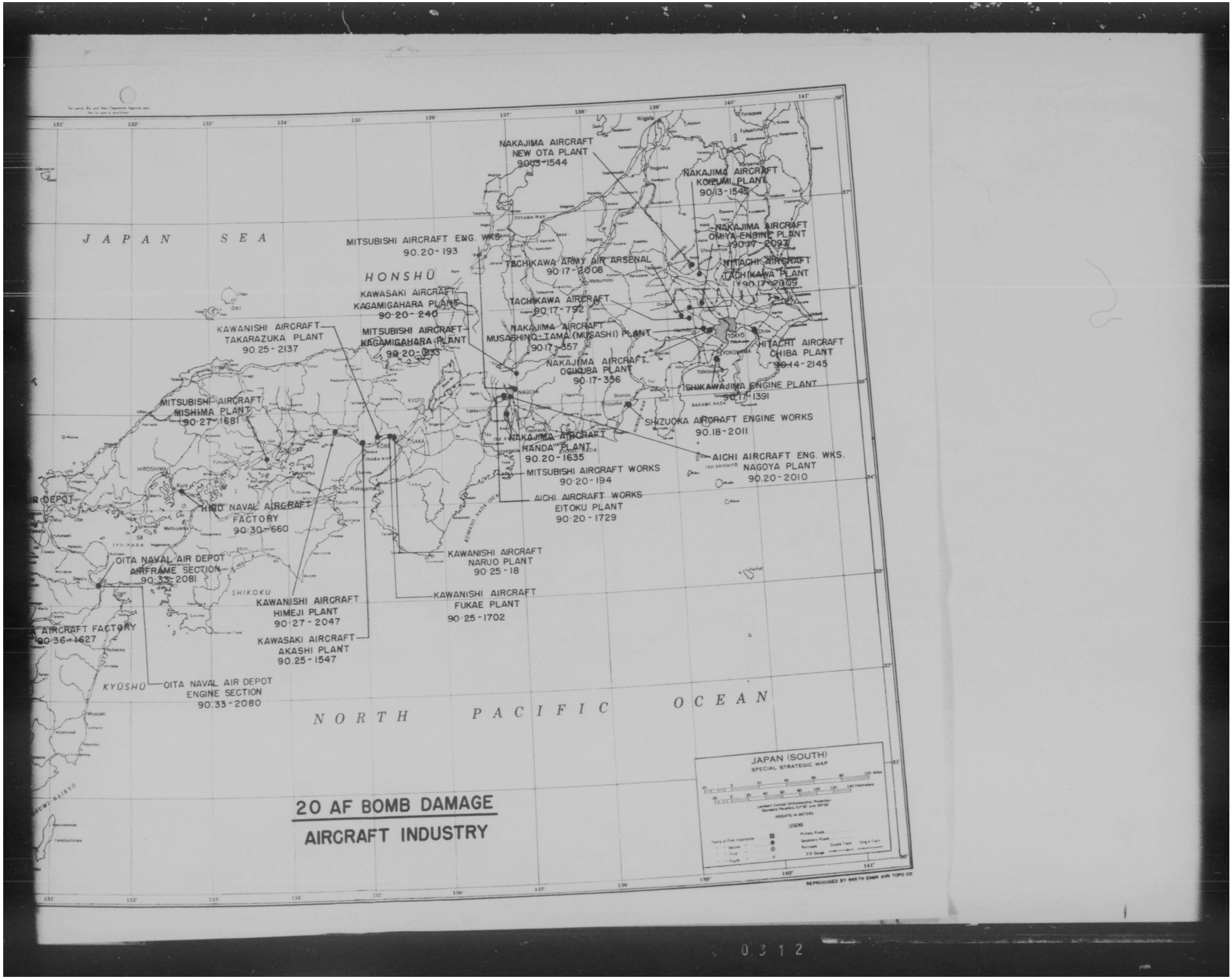




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# TABLE 3
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## PETROLEUM

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| Target No. & Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fusing | Tons | I.B. BOMBS ON TARGET Type | Fusing | Tons | Aiming Point W. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage A Flash Reports (F/R) as indicat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.8-1066 Nippon Oil Company, Tsuchizaki | 328 | 8-14-45 | 315th Wing | 130 | 12,800' | M 64 GPs | Inst. nose, N.D.tail | 1286 | | | | 074126 | Tsuchizaki Area | No post-strike photography |
| 90.17-116/127 Mitsubish Oil Refinery--Hayama Oil Refinery, Kawasaki | 291 | 7-25-45 | 315th Wing | 75 | 17,500' | M 64 GPs | 1/10 nose,1/10 tail | 669.0 | | | | 121015 | Kawasaki Urban Area | Results unobserved |
| | 310 | 8-1-45 | 315th Wing | 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | 121015<br>135150 | Kawasaki Urban Area | Extensive damage to both targets include storage capacity (39%) (D/A #173) |
| 90.17-128 Kawasaki Petroleum Center | 267 | 7-12-45 | 315th Wing | 53 | 15,500' | M 64 GPs | 1/10 nose, 1/40 tail | 452.0 | | | | 135150 | Kawasaki Urban Area | 204,800 sq ft (27.6%) of rf area destro storage capacity (9%) destroyed/damaged |
| | 310 | 8-1-45 | 315th Wing | 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | 121015,135150 | Kawasaki Urban Area | Unobserved results and no photo cover |
| 90.20-1684 Utsube Oil Refinery, Yokkaichi | 232 | 8-21-45 | 315th Wing | 38 | 15,500' | GPs | 1/40 nose,N.D. tail | 222.8 | | | | 068019 | 90.20-1684 | 645,750 sq ft (54%) of rf area destroyed |
| | 261 | 7-9-45 | 315th Wing | 61 | 16,000' | M 64 GPs | 1/40 nose,N.D. tail | 468.7 | | | | 0750266,062018 | Yokkaichi Area | Total damage 946,940 sq ft (45.6%) dest |
| 90.25-1303 Nippon Oil Company, Amagasaki | 281 | 7-19-45 | 315th Wing | 83 | 14,000' | M 64 GPs | 1/10 nose,1/40 tail | 701.8 | | | | 055066 | Amagasaki/Osaka Urban Area | Excellent results with most tanks and b |
| | 322 | 8-9-45 | 315th Wing | 93 | 15,450' | M 64 GPs | 1/10 nose,N.D. tail | 884.2 | | | | 055066 | Amagasaki/Osaka Urban Area | Both raids completely destroyed this pl |
| 90.25-1764 Marusen Oil Refinery, Minoshima | 245 | 7-2-45 | 315th Wing | 39 | 15,500' | M 64 GPs | 1/40 nose, Inst. T. | 295.7 | | | | 126093 | Wakayama Area | 54,225 sq ft (10.4%) of rf area destroy |
| | 255 | 7-6-45 | 315th Wing | 59 | 11,000' | M 64 GPs | 1/40 nose, N.D. tail | 441.5 | | | | 126093 | Wakayama Area | Damage increased to 900,000 sq ft (88%) 900,000 bbls of storage capacity destro |
| 90.25-2252 Shimotsu Oil Refinery, Wakayama | 303 | 7-28-45 | 315th Wing | 76 | 11,000' | M 64 GPs | 1/10 nose, N.D. tail | 558.3 | | | | 067071 | Wakay a Area | Results unobserved - no photography |
| 90.30-2121 Otake Oil Refinery, Otake | 165 | 5-10-45 | 314th Wing | 112 | 17,000' | M 64 GPs | Inst. nose, N.D.tail | 549.2 | | | | 095104 | 90.30-2121 | 45% of installation destroyed/damaged |
| 90.32-872 Nippon Oil Company, Kudamatsu | 238 | 6-30-45 | 315th Wing | 32 | 16,000' | M 64 GPs | 1/10 nose,1/100 tail | 208.5 | | | | 048016 | Tokuyama Approach | Slight damage (F/R #385) |
| | 270 | 7-15-45 | 315th Wing | 59 | 11,000' | M 64 GPs | 1/10 nose,1/100 tail | 493.8 | | | | 048016 | Tokuyama Approach | 20% of installation destroyed/damaged f |
| 90.32-873 Tokuyama Naval Fueling Station | 165 | 5-10-45 | 73rd Wing | 54 | 17,500' | GPs- | Inst. nose,N.D. tail | 242.8 | | | | 059058 | Tokuyama Approach | 566,150 sq ft (49.6%) of rf area destr |
| 90.32-874 Tokuyama Synthetic Oil Plant | 164 | 5-10-45 | 73rd Wing | 56 | 20,000' | GPs | Inst. nose,N.D. tail | 261.5 | | | | 054087 | Tokuyama Approach | 32% of by-products tanks destroyed/dam |
| 90.32-1841 Ube Coal Liquefaction Co., Ube | 283 | 7-22-45 | 315th Wing | 72 | 14,000' | M64 & 43 | 1/10 nose,1/100 tail | 620.5 | | | | 097122 | 90.32-1841 | Results unobserved |
| | 315 | 8-5-45 | 315th Wing | 106 | 11,080' | M 64 GPs | 1/10 nose,1/100 tail | 904.2 | | | | 097122 | 90.32-1841 | Total damage is 100% of refining & 80% |
| 90.32-1884 O Shima Oil Storage, O Shima | 166 | 5-10-45 | 58th Wing | 80 | 17,500' | M 64 GPs | | 383.2 | | | | 086051<br>064042 | Tokuyama Area | 45,000 sq ft (90%) of rf area destroye storage capacity destroyed/damaged (D |

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports, and Damage Assessment Reports)

# TABLE 4
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## OTHER INDUSTRIAL TARGETS

| Target No. & Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fusing | Tons | I.B. BOMBS ON TARGET Type | Fusing | Tons | Aiming Point W. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Flash Reports (F/R) as indic |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.10-2025 Hodogaya Chemical Ind., Koriyama | 64 | 4-12-45 | 313th Wing | 66 | 8,000' | M 64 GPs | .01 nose, N.D. tail | 273.8 | | | | 089078 | Koriyama Area | 457,900 sq ft (59%) of rf area destroy |
| 90.10-YII 6129 Koriyama Chemical Ind., Koriyama | 64 | 4-12-45 | 314th Wing | 70 | 7,975' | M 64 GPs | .01 nose, N.D. tail | 171.8 | | | | 089078 | Koriyama Area | 555,000 sq ft (72.8%) of rf area dest |
| 90.14-1478 Hitachi Engineering Works, Kaigan Plant | 197 | 6-13-45 | 73rd Wing | 118 | 20,500' | M 66 | Variable delay nose 1/40 tail | 906.0 | | | | | | 2,142,900 sq ft (96.8%) of rf area de |
| 90.20-196 Chigusa Factory, Nagoya Arsenal | 226 | 6-26-45 | 314th Wing | 33 | 17,500' | GPs | 1/40 nose, N.D.tail | 189.5 | | | | 076032 | 90.20-193 | Prior damage (M-59, Target 193) 284,0 Damage from this raid and urban raids of roof area destroyed/damaged |
| 90.20-197/241 Atsuta Factory, Nagoya Arsenal Nippon Vehicle Co. | 227 | 6-26-45 | 314th Wing | 25 | 17,500' | GPs | 1/40 nose,N.D. tail | 143.8 | | | | 123032 | 90.20-197 | Damage from this strike 485,950 sq ft Prior damage, incidental to strikes a 193 is 862,000 sq ft (34%) D/A #82 br to 1,327,950 (53%) of rf area destroy strike on Target 241 is 282,230 sq ft brought to 549,330 sq ft (61.4%) of r |

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# TABLE 3
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## PETROLEUM

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| Participating Units | A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fusing | Tons | I.B. BOMBS ON TARGET Type | Fusing | Tons | Aiming Point M. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Assessment Reports (D/A) and Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 315th Wing | 130 | 12,600' | M 64 GPs | Inst. nose, N.D.tail | 1286 | | | | 074126 | Tsuchizaki Area | No post-strike photography |
| 315th Wing | 75 | 17,500' | M 64 GPs | 1/10 nose,1/10 tail | 668.0 | | | | 121015 | Kawasaki Urban Area | Results unobserved |
| 315th Wing | 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | 121015 | Kawasaki Urban Area | Extensive damage to both targets includes destruction of 911,125 bbls storage capacity (39%) (D/A #173) |
| 315th Wing | 53 | 15,500' | M 64 GPs | 1/10 nose, 1/40 tail | 452.0 | | | | 135150 | Kawasaki Urban Area | 204,800 sq ft (27.6%) of rf area destroyed/damaged--117,800 bbls of storage capacity (9%) destroyed/damaged (D/A #157) |
| 315th Wing | 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | 121015,135150 | Kawasaki Urban Area | Unobserved results and no photo cover |
| 315th Wing | 33 | 15,500' | GPs | 1/40 nose,N.D. tail | 222.8 | | | | 068019 | 90.20-1684 | 645,750 sq ft (54%) of rf area destroyed/damaged |
| 315th Wing | 61 | 16,000' | M 64 GPs | 1/40 nose,N.D. tail | 468.7 | | | | 0750266,062018 | Yokkaichi Area | Total damage 946,940 sq ft (45.6%) destroyed/damaged (D/A #141) |
| 315th Wing | 83 | 16,000' | M 64 GPs | 1/10 nose,1/40 tail | 701.8 | | | | 055068 | Amagasaki/Osaka Urban Area | Excellent results with most tanks and bldgs destroyed/damaged (D/A #155) |
| 315th Wing | 93 | 15,450' | M 64 GPs | 1/10 nose,N.D. tail | 884.2 | | | | 055066 | Amagasaki/Osaka Urban Area | Both raids completely destroyed this plant (F/R #403) |
| 315th Wing | 39 | 15,500' | M 64 GPs | 1/40 nose, Inst. N. | 298.7 | | | | 126093 | Wakayama Area | 54,225 sq ft (10.4%) of rf area destroyed/damaged |
| 315th Wing | 59 | 11,000' | M 64 GPs | 1/40 nose, N.D. tail | 441.5 | | | | 126093 | Wakayama Area | Damage increased to 900,000 sq ft (88%) of rf area destroyed/damaged & 900,000 bbls of storage capacity destroyed/damaged (D/A #142) |
| 315th Wing | 76 | 11,000' | M 64 GPs | 1/10 nose, N.D. tail | 658.3 | | | | 087071 | Wakayama Area | Results unobserved - no photography |
| 314th Wing | 112 | 17,000' | M 64 GPs | Inst. nose, N.D.tail | 549.2 | | | | 095104 | 90.30-2121 | 45% of installation destroyed/damaged (D/A #74) |
| 315th Wing | 32 | 16,000' | M 64 GPs | 1/10 nose,1/100 tail | 208.5 | | | | 048016 | Tokuyama Approach | Slight damage (F/R #385) |
| 315th Wing | 59 | 11,000' | M 64 GPs | 1/10 nose,1/100 tail | 493.8 | | | | 048016 | Tokuyama Approach | 20% of installation destroyed/damaged from Missions 238 & 270 (F/R #385) |
| 73rd Wing | 54 | 17,500' | GPs- | Inst. nose,N.D. tail | 242.8 | | | | 059058 | Tokuyama Approach | 565,150 sq ft (49.8%) of rf area destroyed/damaged (D/A #75) |
| 73rd Wing | 56 | 20,000' | GPs | Inst. nose,N.D. tail | 261.5 | | | | 054087 | Tokuyama Approach | 32% of by-products tanks destroyed/damaged (D/A #73) |
| 315th Wing | 72 | 14,000' | M64 & 43 | 1/10 nose,1/100 tail | 620.5 | | | | 097122 | 90.32-1841 | Results unobserved |
| 315th Wing | 106 | 11,080' | M 64 GPs | 1/10 nose,1/100 tail | 904.2 | | | | 097122 | 90.32-1841 | Total damage is 100% of refining & 80% of stores destroyed/damaged F/R #385 |
| 313th Wing | 80 | 17,500' | M 64 GPs | | 335.2 | | | | 066051 | Tokuyama Area | 45,000 sq ft (90%) of rf area destroyed/damaged and 1,197,000 bbls of storage capacity destroyed/damaged (D/A #72) |
| | | | | | | | | | 064042 | | |

Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports, and Damage Assessment Reports)

# TABLE 4
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## OTHER INDUSTRIAL TARGETS

| Participating Units | A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fusing | Tons | I.B. BOMBS ON TARGET Type | Fusing | Tons | Aiming Point M. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Assessment Reports (D/A) and Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6th Wing | 66 | 8,000' | M 64 GPs | .01 nose, N.D. tail | 273.8 | | | | 089078 | Koriyama Area | 457,900 sq ft (59%) of rf area destroyed/damaged (D/A #41) |
| 6th Wing | 70 | 7,875' | M 64 GPs | .01 nose, N.D. tail | 171.3 | | | | 089078 | Koriyama Area | 555,000 sq ft (72.8%) of rf area destroyed/damaged (D/A #57) |
| 4 Wing | 118 | 20,500' | M 66 | Variable delay nose 1/40 tail | 876.0 | | | | | | 2,142,900 sq ft (98.8%) of rf area destroyed/damaged (D/A #127) |
| 6th Wing | 33 | 17,500' | GPs | 1/40 nose, N.D.tail | 139.5 | | | | 076032 | 90.20-193 | Prior damage (M-59, Target 193) 284,000 sq ft destroyed/damaged (D/A #45 Damage from this raid and urban raids totals 1,228,060 sq ft (77%) of roof area destroyed/damaged |
| 6th Wing | 25 | 17,500' | GPs | 1/40 nose,N.D. tail | 143.8 | | | | 123032 | 90.20-197 | Damage from this strike 485,950 sq ft (13.7%) destroyed/damaged (D/A#128 Prior damage, incidental to strikes against targets Nagoya Urban and 193 is 862,000 sq ft (34%) D/A #82 bringing total damage to Target 197 to 1,327,950 (53%) of rf area destroyed/damaged----Damage from this strike on Target 241 is 282,230 sq ft; with prior damage total is brought to 549,330 sq ft (61.4%) of rf area destroyed/damaged (D/A #128) |



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| Target No. & Name | on No. | Date | Units | Target | Altitude | Type | Fuzing | Tons | Type | Fuzing | Tons | | | Aiming Point M. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Assessment Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.6-1066 Nippon Oil Company, Tsuchizaki | 328 | 8-14-45 | 315th Wing | 130 | 12,800' | M 64 GPs | Inst. nose, N.D.tail | 1286 | | | | | | 074126 | Tsuchisaki Area | No post-strike photography |
| 90.17-116/127 Mitsubishi Oil Refinery--Mayama Oil Refinery, Kawasaki | 291 | 7-28-45 | 315th Wing | 75 | 17,500' | M 64 GPs | 1/10 nose,1/10 tail | 668.0 | | | | | | 121015 | Kawasaki Urban Area | Results unobserved |
| | 310 | 8-1-45 | 315th Wing | 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | | | 121015 | Kawasaki Urban Area | Extensive damage to both targets includes de storage capacity (39%) (D/A #173) |
| 90.17-128 Kawasaki Petroleum Center | 287 | 7-12-45 | 315th Wing | 53 | 15,500' | M 64 GPs | 1/10 nose, 1/40 tail | 462.0 | | | | | | 135150 | Kawasaki Urban Area | 204,800 sq ft (27.6%) of rf area destroyed/d storage capacity (9%) destroyed/damaged (D/A |
| | 310 | 8-1-45 | 315th Wing | 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | | | 121015,135150 | Kawasaki Urban Area | Unobserved results and no photo cover |
| 90.20-1684 Utsube Oil Refinery, Yokkaichi | 232 | 6-21-45 | 315th Wing | 38 | 15,500' | GPs | 1/40 nose,N.D. tail | 222.8 | | | | | | 068019 | 90.20-1684 | 645,750 sq ft (34%) of rf area destroyed/dam |
| | 261 | 7-9-45 | 315th Wing | 61 | 16,000' | M 64 GPs | 1/40 nose,N.D. tail | 468.7 | | | | | | 0750266,062018 | Yokkaichi Area | Total damage 946,940 sq ft (45.6%) destroyed |
| 90.25-1208 Nippon Oil Company, Amagasaki | 281 | 7-19-45 | 315th Wing | 83 | 16,000' | M 64 GPs | 1/10 nose,1/40 tail | 701.8 | | | | | | 055066 | Amagasaki/Osaka Urban Area | Excellent results with most tanks and bldgs |
| | 322 | 8-9-45 | 315th Wing | 93 | 15,450' | M 64 GPs | 1/10 nose,N.D. tail | 884.2 | | | | | | 055066 | Amagasaki/Osaka Urban Area | Both raids completely destroyed this plant ( |
| 90.25-1764 Maruzen Oil Refinery, Minoshima | 245 | 7-2-45 | 315th Wing | 39 | 15,500' | M 64 GPs | 1/40 nose, Inst. T. | 298.7 | | | | | | 126093 | Wakayama Area | 54,225 sq ft (10.4%) of rf area destroyed/da |
| | 255 | 7-6-45 | 315th Wing | 59 | 11,000' | M 64 GPs | 1/40 nose, N.D. tail | 441.5 | | | | | | 126093 | Wakayama Area | Damage increased to 900,000 sq ft (88%) of r 900,000 bbls of storage capacity destroyed/ |
| 90.25-2252 Shimotsu Oil Refinery, Wakayama | 303 | 7-28-45 | 315th Wing | 76 | 11,000' | M 64 GPs | 1/10 nose, N.D. tail | 658.5 | | | | | | 067071 | Wakayama Area | Results unobserved - no photography |
| 90.30-2121 Otake Oil Refinery, Otake | 165 | 5-10-45 | 314th Wing | 112 | 17,000' | M 64 GPs | Inst. nose, N.D.tail | 549.2 | | | | | | 095104 | 90.30-2121 | 45% of installation destroyed/damaged (D/A |
| 90.32-872 Nippon Oil Company, Kudamatsu | 238 | 6-30-45 | 315th Wing | 32 | 16,000' | M 64 GPs | 1/10 nose,1/100 tail | 208.5 | | | | | | 048016 | Tokuyama Approach | Slight damage (F/R #385) |
| | 270 | 7-15-45 | 315th Wing | 59 | 11,000' | M 64 GPs | 1/10 nose,1/100 tail | 493.8 | | | | | | 048016 | Tokuyama Approach | 20% of installation destroyed/damaged from |
| 90.32-873 Tokuyama Naval Fueling Station | 163 | 5-10-45 | 73rd Wing | 54 | 17,500' | GPs- | Inst. nose,N.D. tail | 242.8 | | | | | | 059058 | Tokuyama Approach | 565,150 sq ft (49.6%) of rf area destroyed/ |
| 90.32-874 Tokuyama Synthetic Oil Plant | 164 | 5-10-45 | 73rd Wing | 56 | 20,000' | GPs | Inst. nose,N.D. tail | 261.5 | | | | | | 054087 | Tokuyama Approach | 32% of by-products tanks destroyed/damaged |
| 90.32-1841 Ube Coal Liquefaction Co., Ube | 283 | 7-22-45 | 315th Wing | 72 | 14,000' | M64 & 43 | 1/10 nose,1/100 tail | 620.5 | | | | | | 097122 | 90.32-1841 | Results unobserved |
| | 315 | 8-5-45 | 315th Wing | 106 | 11,080' | M 64 GPs | 1/10 nose,1/100 tail | 904.2 | | | | | | 097122 | 90.32-1841 | Total damage is 100% of refining & 80% of s |
| 90.32-1884 O Shima Oil Storage, O Shima | 166 | 5-10-45 | 58th Wing | 80 | 17,500' | M 64 GPs | | 385.2 | | | | | | 066051 064042 | Tokuyama Area | 45,000 sq ft (90%) of rf area destroyed/dam storage capacity destroyed/damaged (D/A |

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports, and Damage Assessment Reports)

# TABLE 4
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## OTHER INDUSTRIAL TARGETS

| Target No. & Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | G.B. BOMBS ON TARGET Type | Fuzing | Tons | I.B. BOMBS ON TARGET Type | Fuzing | Tons | Aiming Point M. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Assessment Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.10-2025 Hodogaya Chemical Ind., Koriyama | 64 | 4-12-45 | 313th Wing | 66 | 8,000' | M 64 GPs | .01 nose, N.D. tail | 273.8 | | | | 089078 | Koriyama Area | 457,900 sq ft (59%) of rf area destroyed/ |
| 90.10-XXI 6129 Koriyama Chemical Ind., Koriyama | 64 | 4-12-45 | 314th Wing | 70 | 7,975' | M 64 GPs | .01 nose, N.D. tail | 171.8 | | | | 089079 | Koriyama Area | 555,000 sq ft (72.8%) of rf area destroyed |
| 90.14-1478 Hitachi Engineering Works, Kaigan Plant | 197 | 6-15-45 | 73rd Wing | 118 | 20,500' | M 66 | Variable delay nose 1/40 tail | 806.0 | | | | | | 2,142,900 sq ft (96.8%) of rf area destro |
| 90.20-198 Chigusa Factory, Nagoya Arsenal | 226 | 6-26-45 | 314th Wing | 33 | 17,500' | GPs | 1/40 nose, N.D.tail | 139.5 | | | | 076032 | 90.20-193 | Prior damage (M-59, Target 193) 284,000 s Damage from this raid and urban raids tot of roof area destroyed/damaged |
| 90.20-197/241 Atsuta Factory, Nagoya Arsenal Nippon Vehicle Co. | 227 | 6-26-45 | 314th Wing | 25 | 17,500' | GPs | 1/40 nose,N.D. tail | 145.6 | | | | 123032 | 90.20-197 | Damage from this strike 485,950 sq ft (13 Prior damage, incidental to strikes again 193 is 862,000 sq ft (34%) D/A #82 bringi to 1,327,950 (53%) of rf area destroyed/d strike on Target 241 is 282,230 sq ft; wi brought to 549,330 sq ft (61.4%) of rf ar |
| 90.20-2040 Sumitomo Duralumin Co., Nagoya | 230 | 6-26-45 | 314th Wing | 29 | 21,000' | GPs | 1/40 nose, N.D. tail | 150.0 | | | | 073073 | 90.20-198 | Damage from this raid and urban raids tot 1,339,900 sq ft destroyed/damaged (D/A #1 |
| 90.21-1653 Toyokawa Naval Arsenal | 317 | 8-7-45 | 58th,73rd,313th 314th Wings | 136 | 17,000' | M 64 GPs | 1/10 & 1/100 nose N.D. tail | 765.7 | | | | 090094 076102 | 90.21-1653 | Results excellent (strike photos) |
| 90.25-283A Sumitomo Light Metal Industry, Osaka | 223 | 6-26-45 | 58th Wing | 64 | 22,500' | LCs | Inst.nose, N.D. tail | 382.0 | | | | 039082 | Osaka Area | 282,900 sq ft (11.3%) of rf area destroyed |
| | 284 | 7-24-45 | 58th Wing | 82 | 21,000' | M 56 | 1/40 nose,1/40 tail | 488.0 | | | | 039082 | Osaka Area | Tot. damage 2,105,725 sq ft (95.5%) of ro (D/A #160) 3 adjacent targets also damag |
| 90.25-382 Osaka Army Arsenal | 224 | 6-26-45 | 313th Wing | 109 | 23,000' | GPs | 1/40 nose & tail | 758.0 | | | | 121106,118112 | Osaka Area | 10% of target damaged by M-205 (D/A #99) mission (F/R #302) |
| | 286 | 7-24-45 | 73rd Wing | 153 | 21,500' | M 66 | .025 nose,.025 tail | 1010.0 | | | | 119112 | 90.25-382 | 513,500 sq ft (10%) of rf area destroyed/d |
| | 326 | 8-14-45 | 73rd Wing | 147 | 21,400' | M66 & 65 | .025 nose,.025 tail | 730.0 | | | | 012104,024118 | 90.25-382 | damage is 939,800 sq ft (18.7%) of rf are No post-strike photos for Mission 326. |
| 90.30-657A Kure Naval Arsenal, Kure | 215 | 6-22-45 | 58th & 73rd Wings | 182 | 22,000' | M65,64, M66 | 1/10 & 1/40 nose, 1/40 tail | 795.8 | | | | 037055 | Kure Area | 2,879,510 sq ft (72.0%) of rf area destroy |
| 90.30-2262 Marifu Marshalling Yards, Marifu | 327 | 8-14-45 | 313th Wing | 108 | 16,500' | M 64 GPs | 1/10 nose,1/100 tail | 474.0 | M 47 | 8 sec nose | .8 | 089123 | Iwakuni Area | Target obscured by smoke -- Results unasse |
| 90.32-871 Hikari Naval Arsenal | 325 | 8-14-45 | 58th Wing | 156 | 15,500' | M 64 GPs | 1/100 nose, no tail | 877.0 | M 47 | Inst. nose | .5 | 093051,093084, 111033 | 90.32-871 | Results excellent with partial photograph |

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 17,500' | M 64 GPs | 1/10 nose,1/10 tail | 668.0 | | | | | 121015 | Kawasaki Urban Area | Extensive damage to both targets includes destruction of 971,400 bbls storage capacity (39%) (D/A #173) |
| 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | | 135150 | Kawasaki Urban Area | 204,800 sq ft (27.8%) of rf area destroyed/damaged--117,800 bbls of storage capacity (9%) destroyed/damaged (D/A #157) |
| 53 | 15,500' | M 64 GPs | 1/10 nose, 1/40 tail | 452.0 | | | | | 135150 | | |
| | | | | | | | | | 121015,135150 | Kawasaki Urban Area | Unobserved results and no photo cover |
| 120 | 16,550' | M 64 GPs | 1 sec nose,1/40 tail | 1018.5 | | | | | 068019 | 90.20-1884 | 645,750 sq ft (54%) of rf area destroyed/damaged |
| 38 | 15,500' | GPs | 1/40 nose,N.D. tail | 222.8 | | | | | 0750266,062018 | Tokkaichi Area | Total damage 946,940 sq ft (45.6%) destroyed/damaged (D/A #141) |
| 61 | 16,000' | M 64 GPs | 1/40 nose,N.D. tail | 468.7 | | | | | 055066 | Amagasaki/Osaka Urban Area | Excellent results with most tanks and bldgs destroyed/damaged (D/A #155) |
| 83 | 14,000' | M 64 GPs | 1/10 nose,1/40 tail | 701.8 | | | | | 055066 | Amagasaki/Osaka Urban Area | Both raids completely destroyed this plant (P/R #403) |
| 93 | 15,450' | M 64 GPs | 1/10 nose,N.D. tail | 884.2 | | | | | 126093 | Wakayama Area | 54,225 sq ft (10.4%) of rf area destroyed/damaged |
| 39 | 15,500' | M 64 GPs | 1/40 nose, Inst. T. | 295.7 | | | | | 126093 | Wakayama Area | Damage increased to 900,000 sq ft (88%) of rf area destroyed/damaged & 900,000 bbls of storage capacity destroyed/damaged (D/A #142) |
| 59 | 11,000' | M 64 GPs | 1/40 nose, N.D. tail | 441.5 | | | | | 067071 | Wakayama Area | Results unobserved - no photography |
| 76 | 11,000' | M 64 GPs | 1/10 nose, N.D. tail | 658.5 | | | | | 095104 | 90.30-2121 | 45% of installation destroyed/damaged (D/A #74) |
| 112 | 17,000' | M 64 GPs | Inst. nose, N.D.tail | 549.2 | | | | | 048016 | Tokuyama Approach | Slight damage (P/R #385) |
| 82 | 16,000' | M 64 GPs | 1/10 nose,1/100 tail | 208.5 | | | | | 048016 | Tokuyama Approach | 20% of installation destroyed/damaged from Missions 238 & 270 (P/R #385) |
| 59 | 11,000' | M 64 GPs | 1/10 nose,1/100 tail | 493.8 | | | | | 059058 | Tokuyama Approach | 565,150 sq ft (49.6%) of rf area destroyed/damaged (D/A #73) |
| 54 | 17,500' | GPs- | Inst. nose,N.D. tail | 242.8 | | | | | 054087 | Tokuyama Approach | 32% of by-products tanks destroyed/damaged (D/A #73) |
| 56 | 20,000' | GPs | Inst. nose,N.D. tail | 261.5 | | | | | 097122 | 90.32-1841 | P/R Results unobserved |
| 72 | 14,000' | M64 & 43 | 1/10 nose,1/100 tail | 620.5 | | | | | 097122 | 90.32-1841 | Total damage is 100% of refining & 80% of stores destroyed/damaged #385 |
| 106 | 11,080' | M 64 GPs | 1/10 nose,1/100 tail | 904.2 | | | | | 066051 | Tokuyama Area | 45,000 sq ft (90%) of rf area destroyed/damaged and 1,187,000 bbls of storage capacity destroyed/damaged (D/A #72) |
| 80 | 17,500' | M 64 GPs | | 383.2 | | | | | 064042 | | |

(Compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports, and Damage Assessment Reports)

# TABLE 4
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## OTHER INDUSTRIAL TARGETS

| A/C Over Target | Bombing Altitude | H.E. BOMBS ON TARGET Type | Fusing | Tons | I.B. BOMBS ON TARGET Type | Fusing | Tons | Aiming Point M. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF, CIU Damage Assessment Reports (D/A) and Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|
| 66 | 9,000' | M 64 GPs | .01 nose, N.D. tail | 273.8 | | | | 089078 | Koriyama Area | 457,900 sq ft (59%) of rf area destroyed/damaged (D/A #41) |
| 70 | 7,975' | M 64 GPs | .01 nose, N.D. tail | 171.3 | | | | 089078 | Koriyama Area | 555,000 sq ft (72.8%) of rf area destroyed/damaged (D/A #37) |
| 118 | 20,500' | M 66 | Variable delay nose 1/40 tail | 806.0 | | | | | | 2,142,900 sq ft (96.8%) of rf area destroyed/damaged (D/A #127) |
| 33 | 17,500' | GPs | 1/40 nose, N.D.tail | 139.5 | | | | 076032 | 90.20-193 | Prior damage (M-59, Target 193) 284,000 sq ft destroyed/damaged (D/A #46) Damage from this raid and urban raids totals 1,229,060 sq ft (77%) of roof area destroyed/damaged |
| 25 | 17,500' | GPs | 1/40 nose,N.D. tail | 143.8 | | | | 125032 | 90.20-197 | Damage from this strike 465,950 sq ft (13.7%) destroyed/damaged (D/A#128) Prior damage, incidental to strikes against targets Nagoya Urban and 193 is 862,000 sq ft (34%) D/A #82 bringing total damage to Target 197 to 1,327,950 (53%) of rf area destroyed/damaged----Damage from this strike on Target 241 is 282,230 sq ft; with prior damage total is brought to 549,330 sq ft (61.4%) of rf area destroyed/damaged (D/A #128) |
| 29 | 21,000' | GPs | 1/40 nose, N.D. tail | 150.0 | | | | 075073 | 90.20-198 | Damage from this raid and urban raids totals (55%) of roof area 1,339,900 sq ft destroyed/damaged (D/A #116) |
| 136 | 17,000' | M 64 GPs | 1/10 & 1/100 nose N.D. tail | 765.7 | | | | 090094 076102 | 90.21-1663 | Results excellent (strike photos) |
| 64 | 22,500' | LCs | Inst.nose, N.D. tail | 382.0 | | | | 039082 | Osaka Area | 252,900 sq ft (11.3%) of rf area destroyed/damaged (D/A #119 & Supple.) |
| 82 | 21,000' | M 56 | 1/40 nose,1/40 tail | 488.0 | | | | 039082 | Osaka Area | Tot. damage 2,105,725 sq ft (95.5%) of roof area destroyed/damaged (D/A #160) 3 adjacent targets also damaged from M-223 (D/A #119) |
| 179 | 23,000' | GPs | 1/40 nose & tail | 758.0 | | | | 121105,118112 | Osaka Area | 10% of target damaged by M-203 (D/A #99) No appreciable damage on this mission (F/R #302) |
| 153 | 21,500' | M 66 | .025 nose,.025 tail | 1010.0 | | | | 118112 | 90.25-382 | 513,500 sq ft (10%) of rf area destroyed/damaged (D/A #154). Total |
| 147 | 21,400' | M66 & 65 | .025 nose,.025 tail | 730.0 | | | | 012104,024118 | 90.25-382 | damage is 989,800 sq ft (18.7%) of rf area destroyed/damaged (D/A #160) No post-strike photos for Mission 326. |
| 182 | 22,000' | M65,64, M66 | 1/10 & 1/40 nose, 1/40 tail | 795.6 | | | | 037055 | Kure Area | 2,379,510 sq ft (72.0%) of rf area destroyed/damaged (D/A #149) |
| 108 | 16,500' | M 64 GPs | 1/10 nose,1/100 tail | 474.0 | M 47 | 8 sec nose | .5 | 089123 | Iwakuni Area | Target obscured by smoke -- Results unassessed |
| 158 | 15,500' | M 64 GPs | 1/100 nose, no tail | 877.0 | M 47 | Inst. nose | .5 | 083051,093034, 111033 | 90.32-871 | Results excellent with partial photography showing severe destruction |

(Compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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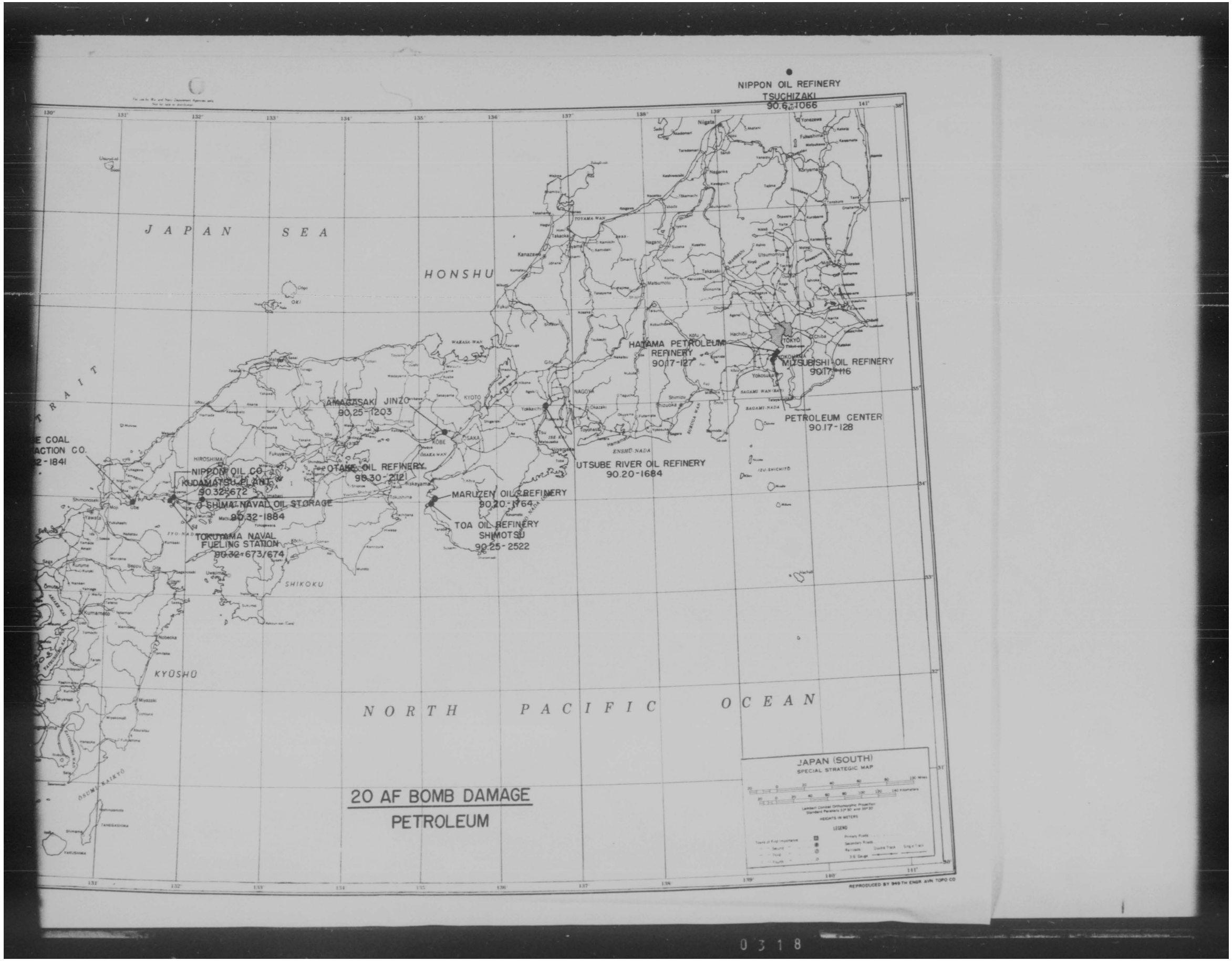


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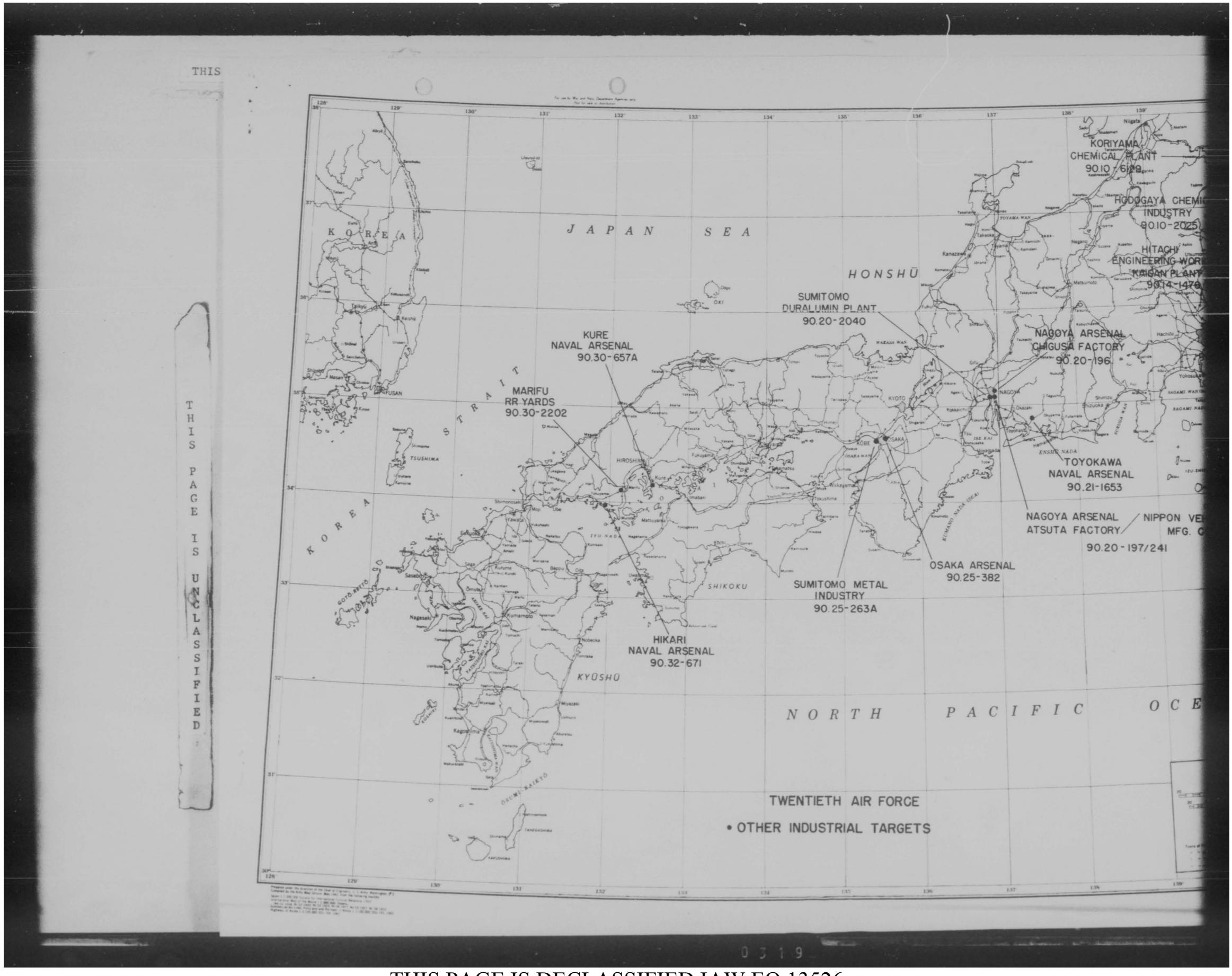


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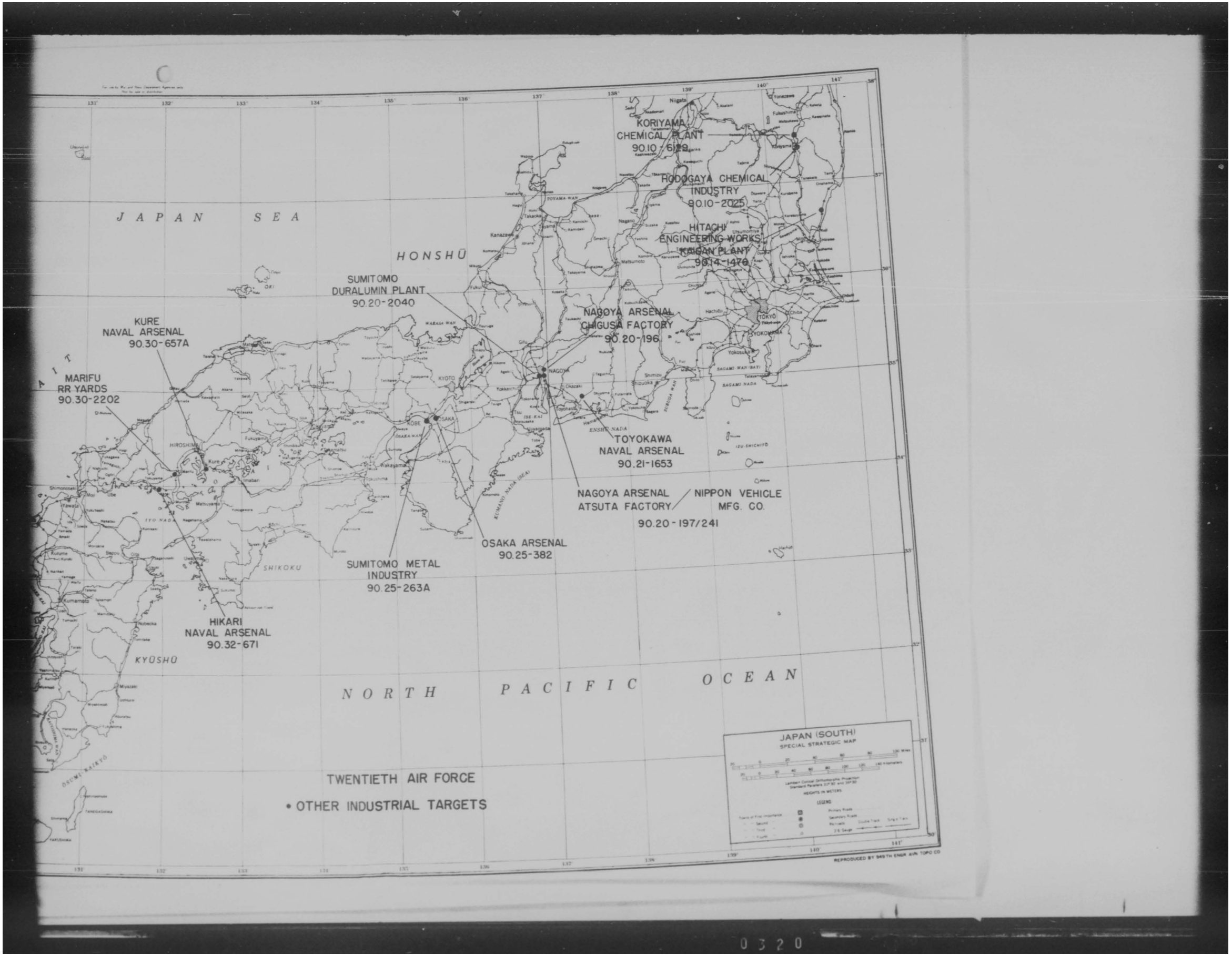


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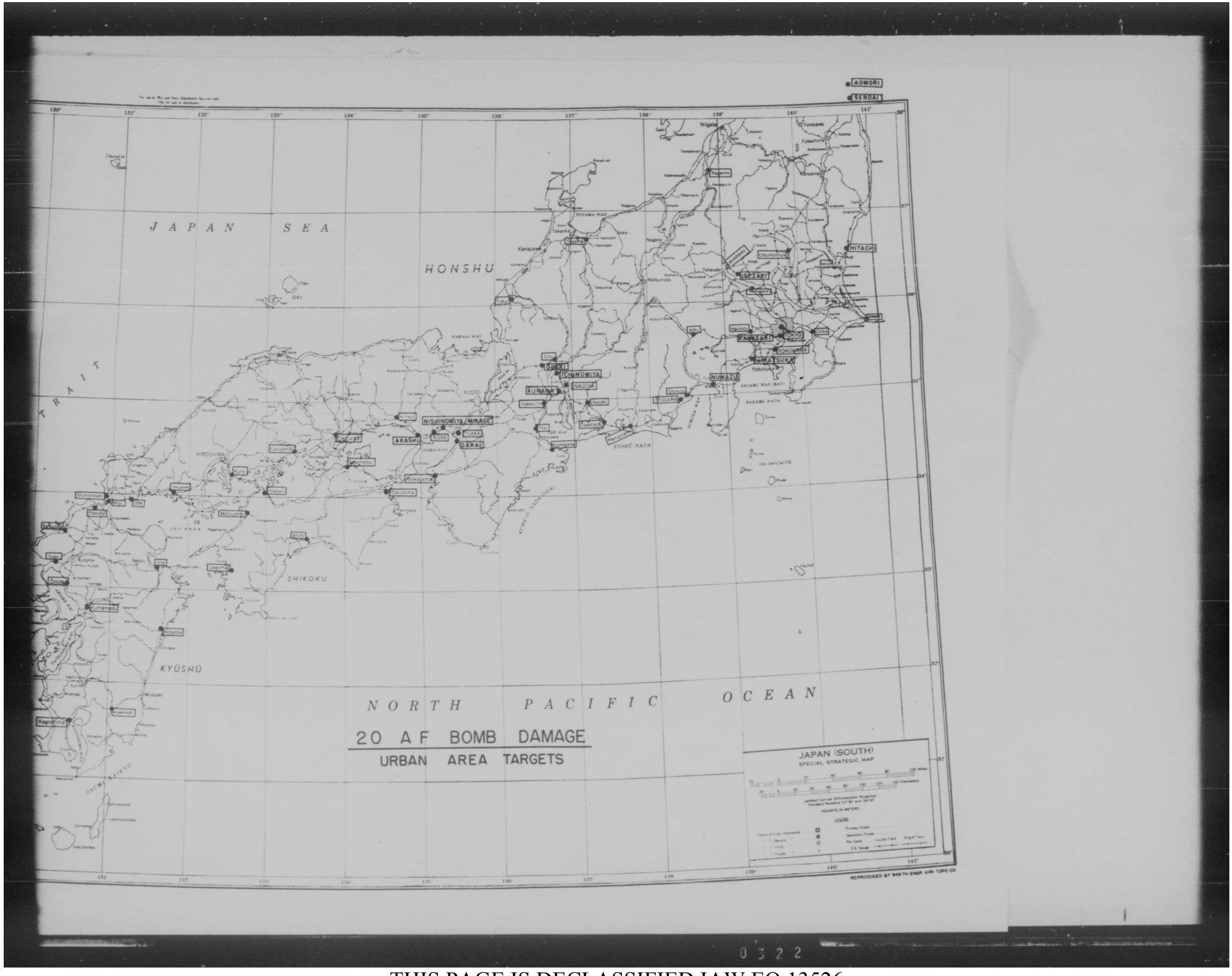


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# TABLE 5
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## AIRFIELDS

CONFIDENTIAL

| Target No. | Target Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | I.B. Bombs on Target: Type | Fusing | Nose | H.E. Bombs on Target: Type | Fusing | Nose | Aiming Point W. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF CIU Damage Assessment Reports (D/A) and Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.14-1491 | Kazumigaura S.S. | 195 | 8-10-45 | 58th Wing | 25 | 18,000' | | | | M 64 GPs | 1/100 nose,N.D. tail | 125.3 | | | 275,300 sq ft (39.8%) of roof area destroyed/damaged (D/A #103) |
| 90.29-2589 | Matsuyama West A/F | 151 | 4-26-45 | 313th Wing | 15 | 24,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 76.5 | 021049 023040 | Matsuyama West | Unobserved results - no photography |
| | | 143 | 5-4-45 | 314th Wing | 17 | 18,000' | | | | M 64 GPs | Inst. to N.D. nose, 1-24 hr tail | 90.3 | 023040 | Matsuyama West | Results fair to good |
| | | 158 | 5-8-45 | 313th Wing | 11 | 19,500' | | | | M65 & 66 | 2-6 hr delay, N.D. to 36 hr delay tail | 76.5 | " | Matsuyama West | Results unobserved - no photography |
| | | 159 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst.nose,1-24 hr tail | 240.0 | 024047 | Matsuyama West | Results good to excellent - 60% of bombs within 1000' of AP (D/A&Sec3,70) |
| 90.33-1307 | Usa A/F | 85 | 4-21-45 | 73rd Wing | 29 | 15,000' | | | | M64,T4 E4 | Inst.nose,N.D. tail 8.5 nose, N.D. tail | 147.2 | | | Results fair to good |
| | | 97 | 4-26-45 | 73rd Wing | 18 | 20,000' | | | | M 64 GPs | No nose to .01 nose & No delay to 24 hr tail | 81.8 | | | Results unobserved - no photography |
| | | 160 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst.nose, N.D. tail | 240.0 | | | Results unobserved |
| | | 164 | 5-7-45 | 313th Wing | 11 | 14,100' | | | | M-65 | 1/100 nose & tail; 2-36 hour delay | 66.1 | | | Final photography shows every bldg destroyed/damaged, N-S runway repaired and remains operative. Field heavily pockmarked (D/A #66) |
| 90.33-1308 | Oita A/F | 82 | 4-21-45 | 73rd Wing | 17 | 14,800' | | | | M 64 GPs | Inst.nose,N.D.-36hr t. | 87.0 | 028075 | 90.33-1308 | Results excellent |
| | | 98 | 4-26-45 | 73rd Wing | 19 | 16,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 86.4 | | | Results unobserved - no photography |
| | | 130 | 4-30-45 | 314th Wing | 10 | 17,500' | | | | M 64 GPs | Inst. to .1 nose, N.D. to 12 hr tail | 58.5 | " | | Results poor |
| | | 140 | 5-4-45 | 314th Wing | 11 | 17,500' | | | | M 64 GPs | Inst. to .01 nose,N.D. to 12 hr tail | 54.8 | 089062 139070 | 90.33-1308 | Negative results |
| | | 144 | 5-5-45 | 314th Wing | 17 | 17,500' | | | | M 64 GPs | Inst. to no nose,1-24 hour delay tail | 105.0 | " | | Results good to excellent |
| | | 153 | 5-7-45 | 313th Wing | 10 | 12,250' | | | | M 65 | 1/100 nose 1/100 tail 2-36 hour delay tail | 66.1 | 136089 | 90.33-1308 | Results poor |
| | | 157 | 5-8-45 | 313th Wing | 12 | 18,500' | | | | M65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 82.5 | " | | Results unobserved - no photography |
| | | 167 | 5-11-45 | 313th Wing | 17 | 18,750' | | | | M65 & 66 | No nose to .01 nose N.D. tail | 86.0 | " | | Results good to excellent (D/A #94) |
| 90.33-2531 | Nittagahara A/F | 74 | 4-17-45 | 314th Wing | 7 | 18,250' | | | | T4 E4 Frag | 8.5 nose, N.D. tail | 24.5 | 071085 | Nittagahara A/F | Results good |
| | | 81 | 4-18-45 | 314th Wing | 8 | 18,100' | | | | T4 E4 Frag | 8.5 nose, N.D. tail | 25 | 071085 | Nittagahara A/F | Results good |
| | | 90 | 4-21-45 | 314th Wing | 22 | 15,750' | | | | M 64 GPs | Inst. nose, No tail | 97 | 071085 | Nittagahara A/F | Results fair |
| | | 102 | 4-26-45 | 313th Wing | 18 | 18,000' | | | | M 64 GPs | No nose to .01 nose & N.D.-24 hr delay tail | 101.1 | " | | Results unobserved - no photography |
| | | 169 | 5-11-45 | 313th Wing | 5 | 18,500' | | | | M65 & 66 | No--.01 nose,N.D. tail | 27.9 | " | | Results fair to good |
| 90.33-2536 | Tomitaka A/F | 94 | 4-25-45 | 73rd Wing | 18 | 17,000' | | | | M 64 GPs | Inst.nose & tail, 1-36 hour delay | 81.8 | " | | Results fair to good |
| | | 100 | 4-26-45 | 73rd Wing | 21 | 18,500' | | | | M 64 GPs | No nose to .01 nose & N.D.-24 hr delay tail | 95.4 | " | | Results unobserved - no photography |
| | | 131 | 4-30-45 | 314th Wing | 11 | 17,000' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 58.8 | " | | Results good to excellent (D/A #83 |
| 90.33-2537 | Saeki A/F | 95 | 4-26-45 | 73rd Wing | 19 | 22,500' | | | | M 64 GPs | No--.01 nose, N.D.tail | 86.4 | " | | Results unobserved - no photography |
| | | 132 | 4-30-45 | 314th Wing | 11 | 17,425' | | | | M 64 GPs | Inst. to .01 nose--N.D. to 24 hr delay tail | 64.7 | " | | Results poor |
| | | 142 | 5-4-45 | 314th Wing | 9 | 18,350' | | | | M 64 GPs | Inst. to no nose--N.D. to 1-24 hr delay tail | 46.0 | " | | Results fair |
| | | 168 | 5-11-45 | 313th Wing | 7 | 18,750' | | | | M 65 & 66 | No--.01 nose,N.D. tail | 43.0 | " | | Results good (D/A #67 |
| 90.36-1236 | Tachiarai A/F | 71 | 4-17-45 | 73rd Wing | 21 | 15,500' | | | | M 81 | Inst. nose, N.D. tail | 84.3 | 053107,053095 | 90.36-1236 | Results good |
| | | 76 | 4-18-45 | 73rd Wing | 20 | 16,000' | | | | T4E4,M 57 | 8.5 nose, N.D. tail | 24.6 | 053107,052095 | 90.36-1236 | Results good |
| | | 88 | 4-21-45 | 73rd Wing | 17 | 18,900' | | | | M 64 GPs | Inst. nose, N.D. tail | 87.0 | 053107 | 90.36-1236 | Results poor |
| | | 153 | 5-3-45 | 314th Wing | 9 | 18,700' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 51.8 | " | | Results poor to fair |
| | | 145 | 5-5-45 | 314th Wing | 10 | 18,350' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 60.5 | " | | Results poor to fair (D/A #64) |
| 90.36-849 | Omura A/F | 141 | 5-4-45 | 314th Wing | 10 | 18,250' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 42.5 | " | | Results poor (D/A #95) |
| 90.37-2612 | Izumi A/F | 70 | 4-17-45 | 73rd Wing | 20 | 15,500' | | | | M 81 | Inst. nose, N.D. tail | 84.7 | 105095,091090 | Izumi A/F | Results fair to good |
| | | 79 | 4-18-45 | 73rd Wing | 21 | 15,400' | | | | M 81 | Inst. nose, N.D. tail | 67.5 | 105095,091090 | Izumi A/F | Results excellent |
| | | 89 | 4-21-45 | 313th Wing | 12 | 14,300' | | | | M 64 GPs | Inst. nose, N.D. tail | 88.7 | 105096 | Izumi A/F | Results good |
| | | 91 | 4-22-45 | 73rd Wing | 19 | 17,000' | | | | M 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | " | | Results fair to good |
| | | 108 | 4-27-45 | 73rd Wing | 21 | 16,100' | | | | M 64 GPs | Inst.nose,1-24 hr Tail | 96.0 | " | | Results excellent |
| | | 114 | 4-28-45 | 73rd Wing | 23 | 16,250' | | | | M 64 GPs | Inst.nose,1-24 hr Tail | 153.8 | " | | Results fair to good (D/A #66) |
| 90.38-1378 | Kanoya A/F | 75 | 4-17-45 | 314th Wing | 30 | 18,700' | | | | T4E4 Frags | 8.5 nose, N.D. tail | 85.5 | 070097,048105,028095 | Kanoya A/F | Results good to excellent |
| | | 78 | 4-18-45 | 314th Wing | 30 | 18,570' | | | | T4E4 Frags | 8.5 nose, N.D. tail | 84.0 | 070097 | Kanoya A/F | Results good |
| | | 84 | 4-21-45 | 314th Wing | 30 | 16,700' | | | | T4E4 Frags | 8.5 nose, N.D. tail | 136.0 | 070097 | Kanoya A/F | Results fair to excellent |
| | | 96 | 4-22-45 | 313th Wing | 19 | 15,520' | | | | M 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | " | | Results good to excellent |
| | | 104 | 4-26-45 | 314th Wing | 19 | 23,500' | | | | M 64 GPs | No nose to .01 nose, N.D. to 24 hr delay t. | 82.2 | " | | Results unobserved - no photography |
| | | 112 | 4-27-45 | 314th Wing | 20 | 16,500' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 107.0 | " | | Results good to excellent |
| | | 118 | 4-28-45 | 314th Wing | 22 | 16,000' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 117.7 | " | | Results good to excellent |
| | | 124 | 4-29-45 | 314th Wing | 18 | 18,000' | | | | M64 &10LAZ | No nose,N.D. tail | 89.0 | " | | Results good to excellent |
| | | 127 | 4-30-45 | 314th Wing | 11 | 18,200' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 60.9 | " | | Results fair to good |
| | | 136 | 5-3-45 | 314th Wing | 8 | 18,000' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 58.8 | " | | Results excellent |
| | | 147 | 5-5-45 | 314th Wing | 10 | 18,000' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 54.6 | " | | Results good |
| | | 161 | 5-7-45 | 313th Wing | 10 | 14,400' | | | | M 65 GPs | 1/100 nose & tail,2-36 hour delay tail | 55.5 | 041114 | Kanoya A/F | Results good to excellent |
| | | 155 | 5-8-45 | 313th Wing | 17 | 18,500' | | | | M65 & 66 | 2-6 hr delay, N.D. to 36 hour delay tail | 102.8 | " | | Results unobserved - no photography |
| | | 162 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst. nose, delayed T. | | " | | (D/A #60 and 88) |
| 90.38-1379 | Miyakonojo A/F | 107 | 4-25-45 | 314th Wing | 17 | 17,500' | | | | M 64 GPs | No nose to .01 nose, N.D. to 24 hr delay T. | 104.8 | " | | Results unobserved - no photography |
| | | 111 | 4-27-45 | 313th Wing | 14 | 11,000' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 100.0 | " | | Results fair to good |
| | | 117 | 4-28-45 | 315th Wing | 17 | 11,000' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 121.7 | " | | Results good to excellent |
| | | 121 | 4-29-45 | 73rd Wing | 22 | 15,250' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 136.5 | " | | Results fair to good |
| | | 135 | 5-3-45 | 314th Wing | 11 | 13,000' | | | | M65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 63.1 | " | | Results poor |
| | | 156 | 5-8-45 | 313th Wing | 17 | 18,500' | | | | M 65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 102.8 | " | | Results unobserved - no photography |
| | | 171 | 5-11-45 | 313th Wing | 11 | 18,250' | | | | M 65 & 66 | No nose to .01 nose Non-delay tail | 76.5 | " | | Results unobserved - no photography |
| 90.39-2591 | Chiran A/F | 148 | 5-5-45 | 314th Wing | 8 | 17,100' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 32.0 | 090131 | Chiran A/F South Kyushu Area | Results poor (D/A #92) |
| 90.39-2597 | Ibusuki 33 | 149 | 5-5-45 | 314th Wing | 15 | 17,000' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 55.5 | 036082 | Ibusuki 33 South Kyushu Area | Results good |
| | | 152 | 5-7-45 | 313th Wing | 10 | 12,000' | | | | M 65 GPs | 1/100 nose & tail, 2-36 hr delay | 57.9 | 036081 | Ibusuki 33 South Kyushu Area | Results fair to good (D/A #87) |
| 90.39-2514 | Kanoehisa A/F | 60 | 4-8-45 | 73rd Wing | 29 | 15,150' | | | | M 64 GPs | Inst. nose, 1/40 tail | 128.2 | 041115,029089 | Kanoya A/F | Results good |
| | | 61 | 4-8-45 | 313th Wing | 19 | 17,775' | | | | M 43 GPs | Inst. nose, 1/40 tail | 78.5 | " | | Results unobserved - no photography |
| 90.39-2516 | Kanoya East A/F | 71 | 4-8-45 | 313th Wing | 19 | 17,775' | | | | M 43 GPs | Inst. nose, 1/40 tail | 78.5 | 101128 | Kanoya East A/F | Results unobserved - no photography |
| | | 73 | 4-17-45 | 313th Wing | 20 | 16,850' | | | | M 81 Frags | Inst. nose, N.D. tail | 113.8 | 070117,103122 | | Results fair to good |
| | | 77 | 4-18-45 | 313th Wing | 13 | 16,350' | | | | M 64,T4E4 & M81 Frag | Inst. nose, N.D. tail Fused to open 2000' | 54.6 | 070117,103122 | | Results poor |
| | | 83 | 4-21-45 | 313th Wing | 27 | 16,750' | | | | M 64 GPs | Inst. nose, N.D. tail | 178.0 | 070117 | | Results good to excellent |
| | | 123 | 4-29-45 | 313th Wing | 14 | 14,250' | | | | M 64 GPs | | | | | |

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# TABLE 5
## TWENTIETH AIR FORCE BOMBARDMENT OF JAPAN
## AIRFIELDS

CONFIDENTIAL

| Target No. | Target Name | Mission No. | Date | Participating Units | A/C Over Target | Bombing Altitude | I.B. Bombs on Target: Type | Fusing | Tons | M.B. Bombs on Target: Type | Fusing | Tons | Aiming Point W. P. I. | Reference 20th AF Litho Mosaic | Results - Based on 20th AF CIU Damage Assessment Reports (D/A) and Flash Reports (F/R) as indicated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.14-1491 | Kasumigaura S.P. | 195 | 8-10-45 | 58th Wing | 25 | 16,000' | | | | M 64 GPs | 1/100 nose,N.D. tail | 123.5 | | | 275,300 sq ft (39.8%) of roof area destroyed/damaged (D/A #103) |
| 90.29-2589 | Matsuyama West A/F | 131 | 4-26-45 | 313th Wing | 15 | 24,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 78.5 | 021048 | Matsuyama West | Unobserved results - no photography |
| | | 143 | 5-4-45 | 314th Wing | 17 | 18,000' | | | | M 64 GPs | Inst. to N.D. nose, 1-24 hr tail | 90.3 | 023040 | Matsuyama West | Results fair to good |
| | | 158 | 5-8-45 | 313th Wing | 11 | 19,500' | | | | M65 & 66 GPs | 2-6 hr delay, N.D. to 36 hr delay tail | 76.5 | " | Matsuyama West | Results unobserved - no photography |
| | | 169 | 5-10-45 | 313th Wing | 42 | 13,500' | | | | M64,74 84 | Inst.nose,1-24 hr tail | 240.0 | 024047 | Matsuyama West | Results good to excellent - 80% of bombs within 1000' of AP (D/A#63,70) |
| 90.33-1307 | Usa A/F | 85 | 4-21-45 | 73rd Wing | 29 | 15,000' | | | | M64,74 84 | Inst.nose,N.D. tail 8.5 nose, N.D. tail | 147.2 | | | Results fair to good |
| | | 97 | 4-26-45 | 73rd Wing | 18 | 20,000' | | | | M 64 GPs | No nose to .01 nose & No delay to 24 hr tail | 81.8 | | | Results unobserved - no photography |
| | | 160 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst.nose, N.D. tail | 240.0 | | | Results unobserved |
| | | 164 | 5-7-45 | 313th Wing | 11 | 14,100' | | | | M 65 | 1/100 nose & tail; 2-36 hour delay | 66.1 | | | Final photography shows every bldg destroyed/damaged, N-S runway repaired and remains operative. Field heavily pockmarked (D/A #66) |
| 90.33-1308 | Oita A/F | 82 | 4-21-45 | 73rd Wing | 17 | 14,800' | | | | M 64 GPs | Inst.nose,N.D.-36hr t. | 87.0 | 026075 | 90.33-1308 | Results excellent |
| | | 98 | 4-26-45 | 73rd Wing | 19 | 15,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 86.4 | | | Results unobserved - no photography |
| | | 150 | 4-30-45 | 314th Wing | 10 | 17,300' | | | | M 64 GPs | Inst. to .1 nose, N.D. to 12 hr tail | 58.5 | " | | Results poor |
| | | 140 | 5-4-45 | 314th Wing | 11 | 17,500' | | | | M 64 GPs | Inst. to .01 nose,N.D. to 12 hr tail | 54.8 | 096062 | | Negative results |
| | | 144 | 5-5-45 | 314th Wing | 17 | 17,500' | | | | M 64 GPs | Inst. to no nose,1-24 hour delay tail | 105.0 | 139070 | 90.33-1308 | Results good to excellent |
| | | 155 | 5-7-45 | 313th Wing | 10 | 12,250' | | | | M 65 | 1/100 nose 1/10 tail 2-36 hour delay tail | 66.1 | 136069 | 90.33-1308 | Results poor |
| | | 157 | 5-8-45 | 313th Wing | 12 | 18,500' | | | | M65 & 66 GPs | 2-6 hr delay,N.D. to 36 hr delay tail | 82.5 | " | | Results unobserved - no photography |
| | | 167 | 5-11-45 | 313th Wing | 17 | 18,750' | | | | M65 & 66 GPs | No nose to .01 nose N.D. tail | 86.0 | " | | Results good to excellent (D/A #94) |
| 90.33-2551 | Nittagahara A/F | 74 | 4-17-45 | 314th Wing | 7 | 18,250' | | | | T4 84 Frag | 8.5 nose, N.D. tail | 24.5 | 071085 | Nittagahara A/F | Results good |
| | | 81 | 4-18-45 | 314th Wing | 8 | 18,100' | | | | T4 84 Frag | 8.5 nose, N.D. tail | 25 | 071085 | Nittagahara A/F | Results good |
| | | 90 | 4-21-45 | 314th Wing | 22 | 15,750' | | | | M 64 GPs | Inst. nose, No tail | 97 | 071085 | Nittagahara A/F | Results fair |
| | | 102 | 4-26-45 | 313th Wing | 18 | 18,000' | | | | M 64 GPs | No nose to .01 nose & N.D.-24 hr delay tail | 101.1 | " | | Results unobserved - no photography |
| | | 169 | 5-11-45 | 313th Wing | 5 | 18,500' | | | | M65 & 66 GPs | No--.01 nose,N.D. tail | 27.9 | " | | Results fair to good |
| 90.33-2556 | Tomitaka A/F | 94 | 4-25-45 | 73rd Wing | 18 | 17,000' | | | | M 64 GPs | Inst.nose & tail, 1-36 hour delay | 81.8 | " | | Results fair to good |
| | | 100 | 4-26-45 | 73rd Wing | 21 | 18,500' | | | | M 64 GPs | No nose to .01 nose & N.D.-24 hr delay tail | 95.4 | " | | Results unobserved - no photography |
| | | 131 | 4-30-45 | 314th Wing | 11 | 17,000' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 58.8 | " | | Results good to excellent (D/A #83 |
| 90.33-2557 | Saeki A/F | 93 | 4-25-45 | 73rd Wing | 19 | 25,500' | | | | M 64 GPs | No--.01 nose, N.D.tail | 86.4 | " | | Results unobserved - no photography |
| | | 132 | 4-30-45 | 314th Wing | 11 | 17,425' | | | | M 64 GPs | Inst. to .01 nose--N.D. to 24 hr delay tail | 64.7 | " | | Results poor |
| | | 142 | 5-4-45 | 314th Wing | 9 | 18,350' | | | | M 64 GPs | Inst. to no nose--N.D. to 1-24 hr delay tail | 46.0 | " | | Results fair |
| | | 169 | 5-11-45 | 313th Wing | 7 | 18,750' | | | | M 65 & 66 | No--.01 nose,N.D. tail | 43.0 | " | | Results good (D/A #67 |
| 90.33-1256 | Machiaral A/F | 71 | 4-17-45 | 73rd Wing | 21 | 15,500' | | | | M 81 | Inst. nose, N.D. tail | 84.2 | 055109,032093 | 90.33-1256 | Results good |
| | | 76 | 4-18-45 | 73rd Wing | 20 | 15,300' | | | | T4B4,M 57 | 8.5 nose, N.D. tail | 28.6 | 055107,032093 | 90.33-1256 | Results good |
| | | 88 | 4-21-45 | 73rd Wing | 17 | 18,800' | | | | M 64 GPs | Inst. nose, N.D. tail | 87.0 | 055107 | 90.33-1256 | Results poor |
| | | 138 | 5-3-45 | 314th Wing | 9 | 18,700' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 51.8 | " | | Results poor to fair |
| | | 148 | 5-5-45 | 314th Wing | 10 | 18,350' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 80.5 | " | | Results poor to fair (D/A #64) |
| 90.33-848 | Omura A/F | 141 | 5-4-45 | 314th Wing | 10 | 18,250' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 42.5 | " | | Results poor (D/A #98) |
| 90.33-2512 | Izumi A/F | 70 | 4-17-45 | 73rd Wing | 20 | 15,500' | | | | M 81 | Inst. nose, N.D. tail | 84.9 | 105095,091090 | Izumi A/F | Results fair to good |
| | | 79 | 4-18-45 | 73rd Wing | 21 | 15,400' | | | | M 81 | Inst. nose, N.D. tail | 67.5 | 105095,091090 | Izumi A/F | Results excellent |
| | | 89 | 4-21-45 | 313th Wing | 13 | 14,300' | | | | M 64 GPs | Inst. nose, N.D. tail | 88.7 | 105096 | Izumi A/F | Results good |
| | | 91 | 4-22-45 | 73rd Wing | 19 | 17,000' | | | | M 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | " | | Results fair to good |
| | | 108 | 4-27-45 | 73rd Wing | 21 | 16,100' | | | | M 64 GPs | Inst.nose,1-24 hr Tail | 96.0 | " | | Results excellent |
| | | 114 | 4-28-45 | 73rd Wing | 23 | 16,250' | | | | M 64 GPs | Inst.nose,1-24 hr Tail | 153.8 | " | | Results fair to good (D/A #68) |
| 90.33-1378 | Kanoya A/F | 75 | 4-17-45 | 314th Wing | 30 | 18,900' | | | | T4B4 Frags | 8.5 nose, N.D. tail | 85.5 | 070097,048105,028053 | Kanoya A/F | Results good to excellent |
| | | 78 | 4-18-45 | 314th Wing | 30 | 18,570' | | | | T4B4 Frags | 8.5 nose, N.D. tail | 84.0 | 070097 | Kanoya A/F | Results good |
| | | 84 | 4-21-45 | 314th Wing | 30 | 16,700' | | | | T4B4 Frags | 8.5 nose, N.D. tail | 136.0 | 070097 | Kanoya A/F | Results fair to excellent |
| | | 95 | 4-22-45 | 313th Wing | 19 | 15,820' | | | | M 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | " | | Results good to excellent |
| | | 104 | 4-26-45 | 314th Wing | 19 | 23,500' | | | | M 64 GPs | No nose to .01 nose, N.D. to 24 hr delay t. | 92.2 | " | | Results unobserved - no photography |
| | | 112 | 4-27-45 | 314th Wing | 20 | 16,500' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 107.0 | " | | Results good to excellent |
| | | 118 | 4-28-45 | 314th Wing | 22 | 16,000' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 117.7 | " | | Results good to excellent |
| | | 124 | 4-29-45 | 314th Wing | 18 | 18,000' | | | | M64 &101A2 | No nose,N.D. tail | 88.0 | " | | Results good to excellent |
| | | 127 | 4-30-45 | 314th Wing | 11 | 18,200' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 60.9 | " | | Results fair to good |
| | | 136 | 5-3-45 | 314th Wing | 8 | 18,000' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 58.8 | " | | Results excellent |
| | | 147 | 5-5-45 | 314th Wing | 10 | 18,700' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 54.6 | " | | Results good |
| | | 161 | 5-7-45 | 313th Wing | 10 | 14,400' | | | | M 65 GPs | 1/100 nose & tail,2-36 hour delay tail | 55.5 | 041114 | Kanoya A/F | Results good to excellent |
| | | 156 | 5-8-45 | 313th Wing | 17 | 18,500' | | | | M65 & 66 GPs | 2-6 hr delay, N.D. to 36 hour delay tail | 102.8 | " | | Results unobserved - no photography |
| | | 162 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst. nose, delayed T. | | " | | (D/A #60 and 88) |
| 90.33-1379 | Miyakonojo A/F | 107 | 4-26-45 | 314th Wing | 19 | 17,500' | | | | M 64 GPs | No nose to .01 nose, N.D. to 24 hr delay T. | 104.6 | " | | Results unobserved - no photography |
| | | 111 | 4-27-45 | 313th Wing | 14 | 11,000' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 100.0 | " | | Results fair to good |
| | | 117 | 4-29-45 | 313th Wing | 17 | 11,500' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 121.7 | " | | Results good to excellent |
| | | 121 | 4-29-45 | 73rd Wing | 22 | 15,250' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 126.5 | " | | Results fair to good |
| | | 135 | 5-3-45 | 314th Wing | 11 | 18,000' | | | | M65 & 66 GPs | 2-6 hr delay,N.D. to 36 hr delay tail | 63.1 | " | | Results poor |
| | | 166 | 5-8-45 | 313th Wing | 17 | 13,500' | | | | M 65 & 66 GPs | 2-6 hr delay,N.D. to 36 hr delay tail | 102.8 | " | | Results unobserved - no photography |
| | | 171 | 5-11-45 | 313th Wing | 11 | 18,250' | | | | M 65 & 66 GPs | No nose to .01 nose Non-delay tail | 76.5 | " | | Results unobserved - no photography |
| 90.33-2551 | Chiran A/F | 148 | 5-5-45 | 314th Wing | 8 | 17,100' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 52.0 | 090131 | Chiran A/F | Results poor (D/A #92) |
| 90.33-2507 | Ibusuki SS | 149 | 5-5-45 | 314th Wing | 15 | 17,900' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 55.0 | 086088 | Ibusuki SS | Results good |
| | | 152 | 5-7-45 | 313th Wing | 10 | 12,000' | | | | M 65 GPs | 1/100 nose & tail, 2-36 hr delay | 57.9 | 086081 | Ibusuki SS | Results fair to good (D/A #87) |
| 90.33-2514 | Kagoshima A/F | 80 | 4-18-45 | 73rd Wing | 29 | 19,150' | | | | M 64 GPs | Inst. nose, 1/40 tail | 128.2 | 041113,029055 | Kanoya A/F | Results good |
| 90.33-2516 | Kanoya East A/F | 72 | 4-17-45 | 313th Wing | 19 | 17,775' | | | | M 43 GPs | Inst. nose, 1/40 tail | 78.8 | " | | Results unobserved - no photography |
| | | 73 | 4-17-45 | 313th Wing | 20 | 16,650' | | | | M 45 GPs | Inst. nose, 1/40 tail | 89.5 | 041128 | Kanoya East A/F | Results unobserved - no photography |
| | | 77 | 4-18-45 | 313th Wing | 13 | 16,350' | | | | M 81 Frags | Inst. nose, N.D. tail | 113.5 | 070117,103122 | | Results fair to good |
| | | 83 | 4-21-45 | 313th Wing | 27 | 16,750' | | | | M 64,T4B4 & M81 Frag | Inst. nose, N.D. tail Fuzed to open 2000' | 54.6 | 070117,103122 | | Results poor |
| | | 123 | 4-29-45 | 313th Wing | 14 | 14,250' | | | | M 64 GPs | Inst. nose, N.D. tail | 178.0 | 070117 | | Results good to excellent |



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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 140 | 4-11-45 | 313th Wing | 9 | 18,700' | | | | M 64 & 66 | No-.01 nose,N.D. tail | 43.0 | * | | Results good (D/A #87) |
| 90,35-1256 | Washizaki A/F | 71 | 4-17-45 | 73rd Wing | 21 | 15,500' | | | | M 81 | Inst. nose, N.D. tail | 84.2 | 053107,053093 | 90,35-1256 | Results good |
| | | 76 | 4-18-45 | 73rd Wing | 20 | 15,000' | | | | T4E4,M 57 | 8.5 nose, N.D. tail | 28.6 | 053107,053093 | 90,35-1256 | Results good |
| | | 88 | 4-21-45 | 73rd Wing | 17 | 18,800' | | | | M 64 GPs | Inst. nose, N.D. tail | 87.0 | 053107 | 90,35-1256 | Results poor |
| | | 133 | 5-3-45 | 314th Wing | 9 | 18,700' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 51.8 | * | | Results poor to fair |
| | | 145 | 5-6-45 | 314th Wing | 10 | 18,350' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 60.5 | * | | Results poor to fair (D/A #84) |
| 90,35-849 | Omura A/F | 141 | 5-4-45 | 314th Wing | 10 | 18,250' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 42.5 | * | | Results poor (D/A #93) |
| 90,37-2512 | Izumi A/F | 70 | 4-17-45 | 73rd Wing | 20 | 15,500' | | | | M 81 | Inst. nose, N.D. tail | 84.7 | 105085,091090 | Izumi A/F | Results fair to good |
| | | 79 | 4-18-45 | 73rd Wing | 21 | 15,400' | | | | M 81 | Inst. nose, N.D. tail | 67.5 | 105095,091090 | Izumi A/F | Results excellent |
| | | 89 | 4-21-45 | 313th Wing | 15 | 14,300' | | | | M 64 GPs | Inst. nose, N.D. tail | 88.7 | 105096 | Izumi A/F | Results good |
| | | 91 | 4-22-45 | 73rd Wing | 19 | 17,000' | | | | M 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | * | | Results fair to good |
| | | 108 | 4-27-45 | 73rd Wing | 21 | 16,100' | | | | M 64 GPs | Inst.nose,1-24 hr Tail | 96.0 | * | | Results excellent |
| | | 114 | 4-28-45 | 73rd Wing | 23 | 16,250' | | | | M 64 GPs | Inst.nose,1-24 hr Tail | 153.8 | * | | Results fair to good (D/A #66) |
| 90,38-1378 | Kanoya A/F | 76 | 4-17-45 | 314th Wing | 30 | 18,700' | | | | T4E4 Frags | 8.5 nose, N.D. tail | 85.5 | 070097,048105,028038 | Kanoya A/F | Results good to excellent |
| | | 78 | 4-18-45 | 314th Wing | 30 | 18,570' | | | | T4E4 Frags | 8.5 nose, N.D. tail | 84.0 | 070097 | Kanoya A/F | Results good |
| | | 84 | 4-21-45 | 314th Wing | 30 | 16,700' | | | | T4E4 Frags | 8.5 nose, N.D. tail | 136.0 | 070097 | Kanoya A/F | Results fair to excellent |
| | | 95 | 4-22-45 | 313th Wing | 19 | 15,520' | | | | M 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | * | | Results good to excellent |
| | | 104 | 4-26-45 | 314th Wing | 19 | 23,500' | | | | M 64 GPs | No nose to .01 nose, N.D. to 24 hr delay t. | 82.2 | * | | Results unobserved - no photography |
| | | 112 | 4-27-45 | 314th Wing | 20 | 16,500' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 107.0 | * | | Results good to excellent |
| | | 118 | 4-28-45 | 314th Wing | 22 | 16,000' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 117.7 | * | | Results good to excellent |
| | | 124 | 4-29-45 | 314th Wing | 18 | 18,000' | | | | M64 &1C1A2 | No nose,N.D. tail | 88.0 | * | | Results good to excellent |
| | | 127 | 4-30-45 | 314th Wing | 11 | 18,200' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 60.9 | * | | Results fair to good |
| | | 136 | 5-3-45 | 314th Wing | 8 | 18,000' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 48.8 | * | | Results excellent |
| | | 147 | 5-5-45 | 314th Wing | 10 | 18,000' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 54.6 | * | | Results good |
| | | 151 | 5-7-45 | 313th Wing | 10 | 14,400' | | | | M 65 GPs | 1/100 nose & tail,2-36 hour delay tail | 55.5 | 041114 | Kanoya A/F | Results good to excellent |
| | | 155 | 5-8-45 | 313th Wing | 17 | 18,500' | | | | M65 & 66 | 2-6 hr delay, N.D. to 36 hour delay tail | 102.8 | * | | Results unobserved - no photography |
| | | 162 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst. nose, delayed T. | | * | | (D/A #60 and 88) |
| 90,38-1379 | Miyakonojo A/F | 107 | 4-26-45 | 314th Wing | 19 | 17,500' | | | | M 64 GPs | No nose to .01 nose, N.D. to 24 hr delay T. | 104.8 | * | | Results unobserved - no photography |
| | | 111 | 4-27-45 | 313th Wing | 14 | 11,000' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 100.0 | * | | Results fair to good |
| | | 117 | 4-28-45 | 313th Wing | 17 | 11,250' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 131.7 | * | | Results good to excellent |
| | | 121 | 4-29-45 | 73rd Wing | 22 | 15,250' | | | | M 64 GPs | Inst. nose, 1-24 hr T. | 126.5 | * | | Results fair to good |
| | | 156 | 5-3-45 | 314th Wing | 11 | 18,000' | | | | M65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 65.1 | * | | Results poor |
| | | 156 | 5-8-45 | 313th Wing | 17 | 18,500' | | | | M 65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 102.8 | * | | Results unobserved - no photography |
| | | 171 | 5-11-45 | 313th Wing | 11 | 19,250' | | | | M 65 & 66 | No nose to .01 nose Non-delay tail | 76.5 | * | | Results unobserved - no photography |
| 90,34-2501 | Chiran A/F | 148 | 5-5-45 | 314th Wing | 8 | 17,100' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 82.0 | 090131 | Chiran A/F South Kyushu Area | Results poor (D/A #92) |
| 90,36-2507 | Tsuiki 3S | 149 | 5-5-45 | 314th Wing | 10 | 17,005' | | | | M 64 GPs | Inst. to no nose, 1-24 hour delay tail | 55.0 | 036062 | Tsuiki 3S South Kyushu Area | Results good |
| | | 152 | 5-7-45 | 313th Wing | 10 | 12,000' | | | | M 65 GPs | 1/100 nose & tail, 2-36 hr delay | 57.9 | 036061 | Tsuiki 3S South Kyushu Area | Results fair to good (D/A #87) |
| 90,34-2514 | Kagoshima A/F | 80 | 4-18-45 | 73rd Wing | 29 | 18,150' | | | | M 64 GPs | Inst. nose, 1/40 tail | 128.2 | 041113,029055 | Kanoya A/F | Results good |
| | | 81 | 4-18-45 | 313th Wing | 19 | 17,775' | | | | M 43 GPs | Inst. nose, 1/40 tail | 78.5 | * | | Results unobserved - no photography |
| 90,34-2516 | Kanoya East A/F | 71 | 4-17-45 | 313th Wing | 19 | 17,775' | | | | M 43 GPs | Inst. nose, 1/40 tail | 78.5 | 101128 | Kanoya East A/F | Results unobserved - no photography |
| | | 73 | 4-17-45 | 313th Wing | 20 | 16,650' | | | | M 81 Frags | Inst. nose, N.D. tail | 113.5 | 070117,103122 | | Results fair to good |
| | | 77 | 4-18-45 | 313th Wing | 13 | 16,350' | | | | M 64,T4E4 & M81 Frag | Inst. nose, N.D. tail Fuzed to open 2000' | 54.6 | 070117,103122 | | Results poor |
| | | 83 | 4-21-45 | 313th Wing | 27 | 16,750' | | | | M 64 GPs | Inst. nose, N.D. tail | 178.0 | 070117 | | Results good to excellent |
| | | 123 | 4-29-45 | 313th Wing | 14 | 14,250' | | | | M 64 GPs | Inst. nose,1-24 hr T. | 72.0 | * | | Results fair to good |
| | | 128 | 4-30-45 | 314th Wing | 10 | 17,100' | | | | M 64 GPs | Inst. to no nose, N.D. to 24 hr delay tail | 59.4 | * | | Results fair to good |
| | | 137 | 5-3-45 | 314th Wing | 11 | 17,400' | | | | M 64 GPs | Inst. to no nose,N.D. to 24 hr delay tail | 58.8 | * | | Results excellent (D/A #85) |
| 90,38-2520 | Kokubu A/F | 72 | 4-17-45 | 313th Wing | 20 | 17,500' | | | | M 81 Frags | Inst. nose, N.D. tail | 134.2 | 061024 | | Results fair to good |
| | | 90 | 4-18-45 | 313th Wing | 19 | 16,250' | | | | M81 & 81 | Inst. nose, N.D. tail | 101.0 | 061024 | | Results fair to excellent |
| | | 96 | 4-21-45 | 313th Wing | 34 | 13,000' | | | | M 64 GPs | Inst. nose, N.D. tail | 218.0 | 061024 | | Results poor to fair |
| | | 104 | 4-26-45 | 314th Wing | 19 | 24,500' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 82.2 | * | | Results unobserved - no photography |
| | | 106 | 4-26-45 | 314th Wing | 17 | 20,570' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 88.0 | * | | Results unobserved - no photography |
| | | 110 | 4-27-45 | 313th Wing | 19 | 11,000' | | | | M 64 GPs | Inst. nose,1-24 hr T. | 117.1 | * | | Results fair to good |
| | | 116 | 4-28-45 | 313th Wing | 17 | 12,125' | | | | M 64 GPs | Inst. nose,1-24 hr T. | 112.9 | * | | Results good to excellent |
| | | 122 | 4-29-45 | 313th Wing | 22 | 12,300' | | | | M 64 GPs | Inst. nose,1-24 hr T. | 140.0 | * | | Results poor |
| | | 129 | 4-30-45 | 314th Wing | 6 | 17,480' | | | | M 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 25.7 | * | | Results good to excellent |
| | | 138 | 5-3-45 | 314th Wing | 9 | 18,500' | | | | M 64 GPs | Inst. to no nose,N.D. to 24 hr delay tail | 48.1 | * | | Results excellent (D/A #85) |
| 90,38-2524 | Kushira A/F | 87 | 4-21-45 | 314th Wing | 28 | 17,450' | | | | M 64 GPs | Inst. nose, N.D. tail | 218.5 | * | | Results poor to fair |
| | | 92 | 4-22-45 | 313th Wing | 11 | 16,000' | | | | M 64 GPs | Inst. nose & tail,1-36 hour delay tail | 49.7 | * | | Results fair to excellent |
| | | 106 | 4-26-45 | 314th Wing | 13 | 24,500' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 71.8 | * | | Results unobserved - no photography |
| | | 113 | 4-27-45 | 314th Wing | 17 | 16,000' | | | | M 64 GPs | Inst. nose,1-24 hr T. | 83.1 | * | | Results excellent |
| | | 119 | 4-28-45 | 314th Wing | 23 | 16,575' | | | | M 64 GPs | Inst. nose,1-24 hr T. | 128.3 | * | | Results good to excellent |
| | | 125 | 4-29-45 | 314th Wing | 16 | 17,350' | | | | M 64 GPs | N.D. nose & tail,2-6 hour delay | 84.0 | * | | Results good to excellent (D/A #67) |
| 90,38-2529 | Miyazaki A/F | 93 | 4-22-45 | 314th Wing | 22 | 15,500' | | | | M 64 GPs | Inst. nose,1-36 hr T. | 101.4 | * | | Results excellent |
| | | 103 | 4-26-45 | 313th Wing | 19 | 15,500' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 94.9 | * | | Results unobserved - no photography |
| | | 105 | 4-26-45 | 314th Wing | 13 | 25,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 71.5 | * | | Results unobserved - no photography |
| | | 107 | 4-26-45 | 314th Wing | 17 | 18,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 104.6 | * | | Results unobserved - no photography |
| | | 109 | 4-27-45 | 73rd Wing | 21 | 12,250' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 95.4 | * | | Results good to excellent |
| | | 115 | 4-28-45 | 73rd Wing | 20 | 12,000' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 137.1 | * | | Results fair to good |
| | | 120 | 4-29-45 | 73rd Wing | 19 | 15,000' | | | | M 64 GPs | Inst.nose,1-24 hr tail | 109.0 | * | | Results excellent |
| | | 134 | 5-3-45 | 314th Wing | 11 | 17,600' | | | | M 64 GPs | Inst. to no nose, N.D. to 24 hr delay tail | 65.5 | * | | Results fair to good |
| | | 161 | 5-10-45 | 313th Wing | 42 | 18,500' | | | | GPs | Inst. nose, N.D. tail | | * | | Results unobserved |
| | | 170 | 5-11-45 | 313th Wing | 12 | 17,500' | | | | M65 & 66 | No nose to .01 nose, N.D. tail | 81.1 | * | | Results unobserved (D/A #71) |
| 90,29- | Tembara (Imabara) A/F | 101 | 4-26-45 | 313th Wing | 15 | 24,000' | | | | M 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 76.5 | 021049 023040 | | Results unobserved - no photography |

*---MPIs will be selected so that bomb patterns will be distributed on strips, ramps and on installations.
(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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|---|---|---|---|---|---|---|---|---|---|---|
| 313th Wing | 7 | 15,750' | | | W 65 & 66 | No--.01 nose,N.D. tail | 43.0 | * | | Results good (D/A #67 |
| 73rd Wing | 21 | 12,500' | | | W 81 | Inst. nose, N.D. tail | 84.2 | 053107,032093 | 90.35-1256 | Results good |
| 73rd Wing | 20 | 15,000' | | | T4E4,W 57 | 8.5 nose, N.D. tail | 28.6 | 053107,032093 | 90.35-1256 | Results good |
| 73rd Wing | 17 | 18,800' | | | W 64 GPs | Inst. nose, N.D. tail | 87.0 | 053107 | 90.35-1256 | Results poor |
| 314th Wing | 9 | 18,700' | | | W 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 51.8 | * | | Results poor to fair |
| 314th Wing | 10 | 18,350' | | | W 64 GPs | Inst. to no nose, 1-24 hour delay tail | 60.5 | * | | Results poor to fair (D/A #64) |
| 314th Wing | 10 | 18,250' | | | W 64 GPs | Inst. to no nose, 1-24 hour delay tail | 42.5 | * | | Results poor (D/A #98) |
| 73rd Wing | 20 | 15,500' | | | W 81 | Inst. nose, N.D. tail | 84.7 | 105095,091090 | Izumi A/F | Results fair to good |
| 73rd Wing | 21 | 15,400' | | | W 81 | Inst. nose, N.D. tail | 67.5 | 105095,091090 | Izumi A/F | Results excellent |
| 313th Wing | 13 | 14,300' | | | W 64 GPs | Inst. nose, N.D. tail | 88.7 | 105096 | Izumi A/F | Results good |
| 73rd Wing | 19 | 17,000' | | | W 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | * | | Results fair to good |
| 73rd Wing | 21 | 16,100' | | | W 64 GPs | Inst.nose,1-24 hr Tail | 96.0 | * | | Results excellent |
| 73rd Wing | 23 | 16,250' | | | W 64 GPs | Inst.nose,1-24 hr Tail | 153.8 | * | | Results fair to good (D/A #68) |
| 314th Wing | 30 | 18,700' | | | T4E4 Frags | 8.5 nose, N.D. tail | 85.5 | 070097,041105,023038 | Kanoya A/F | Results good to excellent |
| 314th Wing | 30 | 18,570' | | | T4E4 Frags | 8.5 nose, N.D. tail | 84.0 | 070097 | Kanoya A/F | Results good |
| 314th Wing | 30 | 18,700' | | | T4E4 Frags | 8.5 nose, N.D. tail | 136.0 | 070097 | Kanoya A/F | Results fair to excellent |
| 313th Wing | 19 | 15,520' | | | W 64 GPs | Inst.nose & tail,1-36 hour delay tail | 86.4 | * | | Results good to excellent |
| 314th Wing | 19 | 23,500' | | | W 64 GPs | No nose to .01 nose, N.D. to 24 hr delay t. | 92.2 | * | | Results unobserved - no photography |
| 314th Wing | 20 | 16,500' | | | W 64 GPs | Inst.nose,1-24 hr tail | 107.0 | * | | Results good to excellent |
| 314th Wing | 22 | 16,000' | | | W 64 GPs | Inst.nose,1-24 hr tail | 117.7 | * | | Results good to excellent |
| 314th Wing | 18 | 18,000' | | | M64 A1C1A2 | No nose,N.D. tail | 88.0 | * | | Results good to excellent |
| 314th Wing | 11 | 18,200' | | | W 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 60.9 | * | | Results fair to good |
| 314th Wing | 8 | 18,000' | | | W 64 GPs | Inst. to no nose, 1-24 hour delay tail | 48.8 | * | | Results excellent |
| 314th Wing | 10 | 18,000' | | | W 64 GPs | Inst. to no nose, 1-24 hour delay tail | 54.6 | * | | Results good |
| 313th Wing | 10 | 14,400' | | | W 65 GPs | 1/100 nose & tail,2-36 hour delay tail | 55.5 | 041114 | Kanoya A/F | Results good to excellent |
| 313th Wing | 17 | 18,500' | | | M65 & 66 | 2-6 hr delay, N.D. to 36 hour delay tail | 102.8 | * | | Results unobserved - no photography |
| 313th Wing | 42 | 18,500' | | | GPs | Inst. nose, delayed T. | | * | | (D/A #60 and 88) |
| 314th Wing | 19 | 17,500' | | | W 64 GPs | No nose to .01 nose, N.D. to 24 hr delay T. | 104.8 | * | | Results unobserved - no photography |
| 313th Wing | 14 | 11,000' | | | W 64 GPs | Inst. nose, 1-24 hr T. | 100.0 | * | | Results fair to good |
| 313th Wing | 17 | 11,000' | | | W 64 GPs | Inst. nose, 1-24 hr T. | 121.7 | * | | Results good to excellent |
| 73rd Wing | 22 | 13,250' | | | W 64 GPs | Inst. nose, 1-24 hr T. | 138.6 | * | | Results fair to good |
| 314th Wing | 11 | 18,000' | | | M65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 63.1 | * | | Results poor |
| 313th Wing | 17 | 18,500' | | | W 65 & 66 | 2-6 hr delay,N.D. to 36 hr delay tail | 102.8 | * | | Results unobserved - no photography |
| 313th Wing | 11 | 18,250' | | | W 65 & 66 | No nose to .01 nose Non-delay tail | 76.5 | * | | Results unobserved - no photography |
| 314th Wing | 8 | 17,100' | | | W 64 GPs | Inst. to no nose, 1-24 hour delay tail | 32.0 | 090131 | Chiran A/F South Kyushu Area | Results poor (D/A #92) |
| 314th Wing | 10 | 17,000' | | | W 64 GPs | Inst. to no nose, 1-24 hour delay tail | 55.0 | 036062 | Ibusuki SS South Kyushu Area | Results good |
| 313th Wing | 10 | 12,000' | | | W 65 GPs | 1/100 nose & tail, 2-36 hr delay | 57.9 | 036061 | Ibusuki SS South Kyushu Area | Results fair to good (D/A #87) |
| 73rd Wing | 29 | 13,150' | | | W 64 GPs | Inst. nose, 1/40 tail | 128.2 | 041113,029035 | Kanoya A/F | Results good |
| 313th Wing | 19 | 17,775' | | | W 43 GPs | Inst. nose, 1/40 tail | 78.5 | * | | Results unobserved - no photography |
| 313th Wing | 19 | 17,775' | | | W 43 GPs | Inst. nose, 1/40 tail | 78.5 | 101128 | Kanoya East A/F | Results unobserved - no photography |
| 313th Wing | 20 | 16,650' | | | W 81 Frags | Inst. nose, N.D. tail | 113.5 | 070117,103122 | | Results fair to good |
| 313th Wing | 13 | 16,350' | | | W 64,T4E4 & M81 Frag | Inst. nose, N.D. tail Fused to open 2000' | 54.6 | 070117,103122 | | Results poor |
| 313th Wing | 27 | 15,750' | | | W 64 GPs | Inst. nose, N.D. tail | 178.0 | 070117 | | Results good to excellent |
| 313th Wing | 14 | 14,250' | | | W 64 GPs | Inst. nose,1-24 hr T. | 72.0 | * | | Results fair to good |
| 314th Wing | 10 | 17,100' | | | W 64 GPs | Inst. to no nose, N.D. to 24 hr delay tail | 59.4 | * | | Results fair to good |
| 314th Wing | 11 | 17,400' | | | W 64 GPs | Inst. to no nose,N.D. to 24 hr delay tail | 58.8 | * | | Results excellent (D/A #65) |
| 313th Wing | 20 | 17,500' | | | W 81 Frags | Inst. nose, N.D. tail | 134.2 | 051024 | | Results fair to good |
| 313th Wing | 19 | 16,250' | | | W51 & 81 | Inst. nose, N.D. tail | 101.0 | 061024 | | Results fair to excellent |
| 313th Wing | 34 | 15,000' | | | W 64 GPs | Inst. nose, N.D. tail | 219.0 | 061024 | | Results poor to fair |
| 314th Wing | 19 | 24,500' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 82.2 | * | | Results unobserved - no photography |
| 314th Wing | 17 | 20,570' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr tail | 88.0 | * | | Results unobserved - no photography |
| 313th Wing | 19 | 11,000' | | | W 64 GPs | Inst. nose,1-24 hr T. | 117.1 | * | | Results fair to good |
| 313th Wing | 17 | 12,125' | | | W 64 GPs | Inst. nose,1-24 hr T. | 112.9 | * | | Results good to excellent |
| 313th Wing | 22 | 12,300' | | | W 64 GPs | Inst. nose,1-24 hr T. | 140.0 | * | | Results poor |
| 314th Wing | 5 | 17,480' | | | W 64 GPs | Inst. to .01 nose, N.D. to 12 hr delay tail | 26.7 | * | | Results good to excellent |
| 314th Wing | 9 | 18,500' | | | W 64 GPs | Inst. to no nose,N.D. to 24 hr delay tail | 48.1 | * | | Results excellent (D/A #55) |
| 314th Wing | 28 | 17,480' | | | W 64 GPs | Inst. nose, N.D. tail | 218.9 | * | | Results poor to fair |
| 313th Wing | 11 | 16,000' | | | W 64 GPs | Inst. nose & tail,1-36 hour delay tail | 49.7 | * | | Results fair to excellent |
| 314th Wing | 13 | 24,500' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 71.5 | * | | Results unobserved - no photography |
| 314th Wing | 17 | 16,000' | | | W 64 GPs | Inst. nose,1-24 hr T. | 83.1 | * | | Results excellent |
| 314th Wing | 23 | 16,575' | | | W 64 GPs | Inst. nose,1-24 hr T. | 128.3 | * | | Results good to excellent |
| 314th Wing | 16 | 17,330' | | | W 64 GPs | N.D. nose & tail,2-6 hour delay | 84.0 | * | | Results good to excellent (D/A #67) |
| 314th Wing | 22 | 15,500' | | | W 64 GPs | Inst. nose,1-36 hr T. | 101.4 | * | | Results excellent |
| 313th Wing | 19 | 15,500' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 94.9 | * | | Results unobserved - no photography |
| 314th Wing | 13 | 25,000' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 71.5 | * | | Results unobserved - no photography |
| 314th Wing | 17 | 18,000' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 104.8 | * | | Results unobserved - no photography |
| 73rd Wing | 21 | 12,250' | | | W 64 GPs | Inst.nose,1-24 hr tail | 95.4 | * | | Results good to excellent |
| 73rd Wing | 20 | 12,000' | | | W 64 GPs | Inst.nose,1-24 hr tail | 132.1 | * | | Results fair to good |
| 73rd Wing | 19 | 15,000' | | | W 64 GPs | Inst.nose,1-24 hr tail | 109.0 | * | | Results excellent |
| 314th Wing | 11 | 17,600' | | | W 64 GPs | Inst. to no nose, N.D. to 24 hr delay tail | 65.5 | * | | Results fair to good |
| 313th Wing | 42 | 18,500' | | | GPs | Inst. nose, N.D. tail | | * | | Results unobserved |
| 313th Wing | 12 | 17,500' | | | M65 & 66 | No nose to .01 nose, N.D. tail | 81.1 | * | | Results unobserved (D/A #71) |
| 313th Wing | 15 | 24,000' | | | W 64 GPs | No nose to .01 nose & N.D. to 24 hr delay T. | 78.5 | 021049 023040 | | Results unobserved - no photography |

*---MPIs will be selected so that bomb patterns will be distributed on strips, ramps and on installations.

(Data compiled from 20th AF Mission Reports, Mission Summaries, Field Orders, Flash Photo Interpretation Reports and Damage Assessment Reports)

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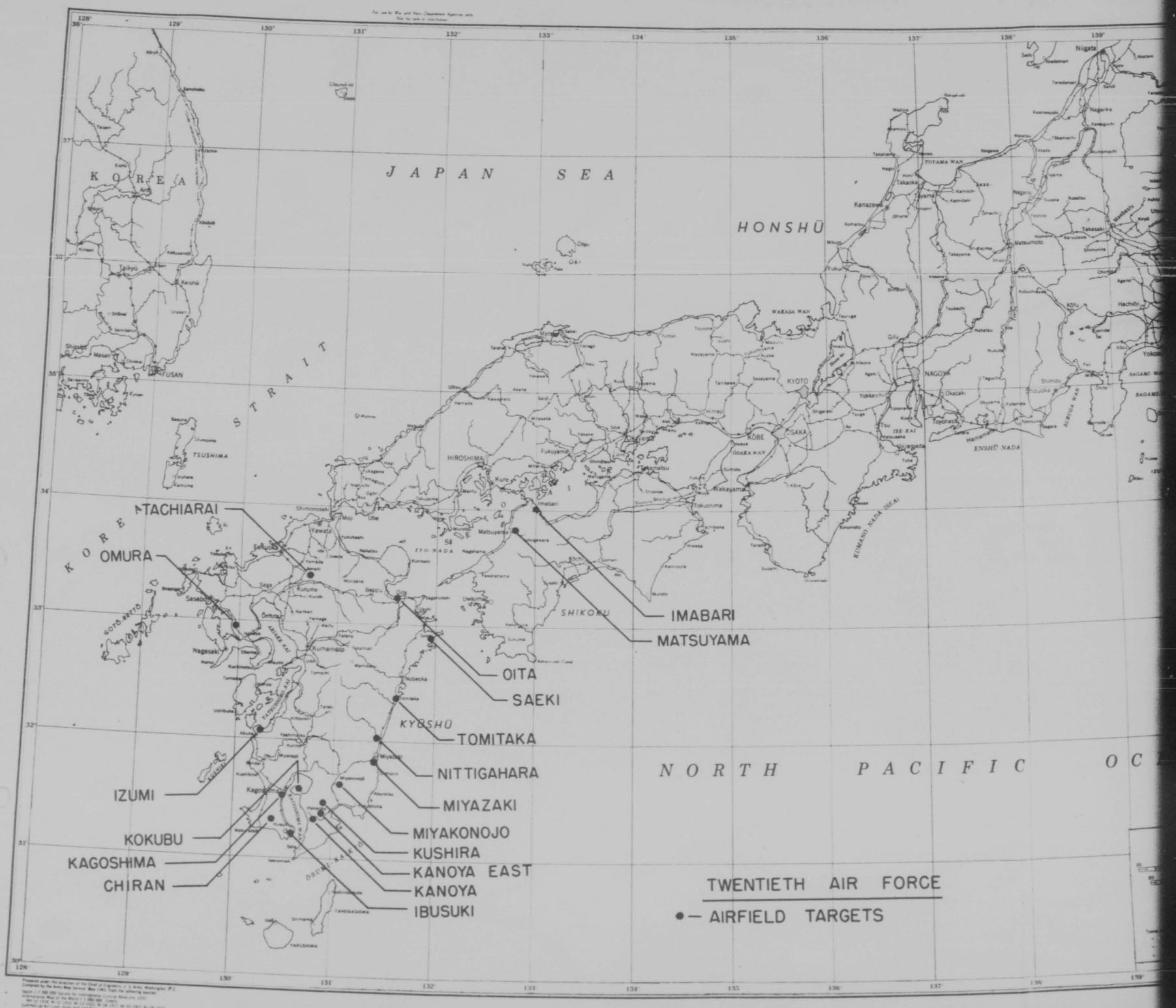




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TWENTIETH AIR FORCE
OPERATIONS ANALYSIS DIVISION
REPORTS and MEMORANDA

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Volume I



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

Gen Grant (1)
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RAG 322

26 July 1944

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MEMORANDUM

Subject: Establishment of Operations Analysis Sections in Twentieth Air Force and Component Commands

1. Dr. Robert L. Stearns has been appointed Chief Operations Analyst, Twentieth Air Force. Dr. Stearns is President of the University of Colorado on leave; he has formerly been Chief Operations Analyst at AFSAT and more recently at Thirteenth Air Force.

2. Operations Analysis Sections are or will be established at Headquarters, Twentieth Air Force, and at all component Bomber Command Headquarters. Such sections have made important contributions to the success of operations in other Air Forces in all theaters.

3. Attention is invited to the directive issued to Dr. Stearns, and attached hereto as Inclosure No. 1.

4. Operations Analysis Sections are staff sections of the Air Force or Command which they serve; are independent of other staff sections; and report to the Chief of Staff or Deputy Chief of Staff. Personnel are usually civilian. They are entitled to the facilities accorded to officers of field grade in all matters, including transportation, communication, billets, access to officers' messes and post exchanges. They carry identification on AGO Form 65-8.

5. Operations Analysts have access to all information of the command in the same manner as staff officers of the command. This includes access to Air Rooms and briefing and interrogation of crews.

6. Any officer desiring study of a problem by the appropriate Operations Analysis Section should recommend such study through the Chief of Staff.

7. Officers at Twentieth Air Force Headquarters should observe that the Operations Analysis Section under Dr. R. L. Stearns is different in organization and function from the Committee of Operations Analysts of which the representatives of the Twentieth Air Force staff are Colonel G. R. Perera and Lt. Colonel W. B. Leach. The Section analyzes tactical problems involved in combat operations and is composed of personnel devoting full time to the Twentieth Air Force. The Committee analyzes the enemy economic system as a basis for selection of targets for strategic bombardment and is composed of representatives of all intelligence agencies, military and civilian, most of whom devote only part time to the Committee work.

By command of General ARNOLD:

H. S. HANSELL, JR.,
Brigadier General, U. S. Army,
Chief of Staff.

1 Incl:
Directive to Dr. Stearns.

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~~R E S T R I C T E D~~

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

RAG 201-Stearns, Robert L. 26 July 1944

SUBJECT: Directive

TO: Dr. Robert L. Stearns, Chief Operations Analyst.

1. Your appointment as Chief Operations Analyst, Twentieth Air Force is hereby confirmed as of 11 May 1944, the date upon which you assumed the duties of this post.

2. In consultation with the Chief of Staff and Deputy Chief of Staff you will form an Operations Analysis Section at Headquarters, Twentieth Air Force. You are hereby designated Chief of this Section. The number and identity of the personnel of this Section will be determined by you from time to time in consultation with the officers above specified. Personnel will be civilian, except as authorized in individual cases, and will be carried on the manning table of the Operations Analysis Division, Management Control.

3. The Operations Analysis Section, Twentieth Air Force, will investigate, study and report upon such problems affecting the operations of the Twentieth Air Force as shall from time to time be approved, in writing or verbally, by the Chief of Staff or Deputy Chief of Staff. At the present time the following studies are approved:

a. Incendiary attack upon strategic localities.

b. Combat formations for the B-29.

c. Flexible gunnery practices and training for the B-29.

d. Non-combat accidents.

e. Combat loss and damage.

In these studies you will cooperate with other staff sections, the Second Air Force, the Air Forces Board, the Navy Department, the Office of Scientific Research and Development and other military and civilian agencies where such cooperation is deemed by you fruitful.

4. You are responsible for the security indoctrination of personnel of this Section and for the observance of proper security practices.

5. You will recommend to the Commanding General, XX Bomber Command, organization, personnel, and fields of investigation for the Operations Analysis Section, XX Bomber Command, for the purpose of making the operational experience of that Command most useful to the Twentieth Air Force as a whole.

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Ltr dtd 26 Jul 44 to Dr. Robert L. Stearns cont'd.

6. For each additional Bomber Command of the Twentieth Air Force, you will organize an Operations Analysis Section of approximately 14, plus clerical assistance. Such Sections will be organized and staffed in consultation with the Commanding General of the Bomber Command, if designated; otherwise with Wing Commanders. In consultation with the above officers, you will determine the time of activating such Sections and the schedule for bringing them up to full strength.

7. You will supervise and coordinate the activities of all Operations Analysts in the Twentieth Air Force and its component commands.

8. All scientific and technical advisers and observers, other than technical representatives of companies whose weapons and equipment are in use by the Twentieth Air Force, will be members of the appropriate Operations Analysis Section while functioning with the Twentieth Air Force and will operate under your direction. You will be responsible for the security indoctrination of such personnel and the observance of proper security practices by them while functioning with this Air Force.

By command of General ARNOLD:

H. S. HANSELL, JR.,
Brigadier General, U. S. Army,
Chief of Staff.

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A/C LOSSES - DAMAGE - ACCIDENTS

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By Authority of
The Commanding General
Army Air Forces

5 Aug 44 RLS
Date Initials

TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

OPERATION ANALYSIS REPORT

SUBJECT: Combat Loss and Damage in the Eighth Air Force (Notes on Statement given to Staff of Twentieth Air Force, 5 August 1944)

DATE: 5 August 1944

AUTHOR: Dr. Richard G. Gettell

IDENTIFICATION: Report No.

Note: Operations Analysis Sections (designated in some theaters as Operational Research Sections) have been established in a number of Air Force Commands pursuant to a memorandum from CG AAF to All Air Force Commanders, dated 24 October 1942, approving this activity.

This is a report of one such Section. Information as to Operations Analysis Sections and reports can be obtained from Operations Analysis Division, Management Control, Headquarters, Army Air Forces, Washington, D. C.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

5 August 1944

Combat Loss and Damage in the Eighth Air Force
(Notes on Statement given to Staff of Twentieth Air Force, 5 August 1944)

Dr. Robert L. Stearns, Chief of the Operations Analysis Section of the Twentieth Air Force, presented Dr. Richard G. Gettell to General Hansell and other members of the Staff of the Twentieth Air Force.

Dr. Gettell, who for the past year and a half has been analyzing losses and combat damage to the heavy bombers of the Eighth Air Force, gave a report summarizing his analysis and recommendations of measures to reduce the amount of loss and damage sustained by bombers, even while improving bombing efficiency. Dr. Gettel is now a member of the Operations Analysis Section of the Twentieth Air Force, continuing in work in like capacity.

A. Scope of Operations Analysis of Combat Loss and Damage

Dr. Gettell's chief assignment was to concern himself with the defensive aspects of bombardment operations. It was his responsibility to analyze the causes of combat losses and damage in order:

(1) To try to determine how losses and damage could be reduced.

(2) To assess the relative importance of various combat risks so that all engineering modifications and tactical alterations designed to reduce costs could be considered with regard to the amount of saving they could be expected to accomplish balanced against any possible loss in offensive efficiency.

B. Importance of Loss and Damage Rates to Offensive Efficiency

Stress was laid on the defensive problem in the Eighth Air Force not only because of the severe opposition encountered in the European Theatre but also because of the great significance of loss and damage rates to the maintenance of a sustained offensive effort.

(1) The great leverage of the loss rate was pointed out by showing that a cut in loss rates from 4% to 2% doubles the combat life of every bomber, -- and is equivalent, over time, to doubling the striking power of a bomber force.

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(2) The significance of battle damage to the offensive effort was found to rest in the repair problem. When 1 in every 3 bombers returned from an operation suffering battle damage and was made non-operational during the period required for repair, the striking force available for a subsequent operation was reduced by 33%.

C. Sources of Information Used in Analysis of Combat Losses and Damage

In conducting his analysis of loss and damage Dr. Gettell relied primarily on the following sources of information:

(1) Battle Damage

Scale drawings of the aircraft were prepared on a grid with 6 views placed back to back. Group Engineers were charged with inspecting each bomber after its return from an operation, and marking on these diagrams the exact damage to each plane, i.e., (a) location of hit, (b) direction from which it came, (c) cause of the damage, wherever it could be determined, and (d) severity of the damage to the plane.

Covering operations from February 1943 through the present, the life history of practically every hole in every heavy bomber is available in the UK. By the end of June, 1944, this record included details of the damage to about 25,000 aircraft. This material has been exhaustively studied, primarily to determine vulnerable areas, the relative frequency of damage to different parts of the plane, and the relative importance of various types of damage.

(2) Combat Losses

Personal interviews were held with first hand witnesses of aircraft lost in combat, -- repatriated or escaped prisoners of war, men who evaded capture after being shot down, and returned through the underground, or internees who returned to the UK, --in order to ascertain the exact circumstances, and the sequence of events which caused their aircraft to be lost.

Although earlier efforts had been made to infer the causes of loss from analysis of the most severe cases of battle damage, it is apparent that there are some circumstances, such as fires and explosions, which, if they occur, will never show up on aircraft which manage to return. By the same token, attempts to determine the causes of loss from A-2 interrogations of returning crews who witnessed the loss of aircraft other than their own, tended to be misleading, particularly in that they grossly understated the importance of flak as a factor in causing straggling. Accordingly, as the evidence began to accumulate from interviews with men who could detail the losses of their own aircraft, much information was obtained which was heretofore unavailable. At present, the stories of over 800 crew members from about 400 different lost aircraft are available. Study of this material has proved to be of tremendous value, not only in explaining losses, but in uncovering other problems of importance to engineering, equipment, and training aspects of heavy bomber operations.

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(--It was pointed out that while information from this kind of source would probably not be available in volume from B-29 operations, it might nevertheless be advisable to organize an attempt to obtain similar information from ditched crews. -- )

D. Pertinence of Loss and Damage Analysis

Analysis of information gathered from the two primary sources mentioned above, when further correlated with the large amount of operational data available within the Eighth Air Force, led to conclusions and recommendations of interest to two parts of the Command. The reduction of combat losses and damage involves such questions as:

(1) Engineering Modifications --what can be done to the plane itself to minimize its vulnerability to all forms of enemy opposition? Work in this field was of prime concern to A-4, Operational Engineering, and Air Technical Sections.

(2) Tactical Adjustments to Changing Combat Risks -- what decisions in the process of planning and executing a bombardment operation tend to increase or decrease combat losses and damage? Are defensive tactics adjusted to the relative importance of the combat hazards encountered? Are anticipated costs balanced against the strategic importance of the targets attacked? In this field, advice and recommendations were presented primarily to the CG, A-3, Air Division and Combat Wing Commanders.

E. Summary of the Analysis

Rather than attempting to review all phases of his work, particularly the complicated problems involved in considering tactical measures to minimize the costs of heavy bomber operations, Dr. Gettell restricted his report to a review of the principal findings in three fields:

(1) The location of damage on a heavy bomber
(2) Recent changes in the relative importance of combat risks
(3) Principal causes of loss, and remedial measures.

For further detail on these points, and for an indication of the Operations Analysis work in other fields related to defense, particularly to tactical problems, it is suggested that reference be made to the following reports prepared by Dr. Gettell and his colleagues in the Operational Research Section, Headquarters, Eighth Air Force:

"Memorandum on Certain Proposed Modifications to the B-17" dated 25 December 1943

"Comments on Certain Proposed Modifications to B-24 Aircraft" dated 8 January 1944

"Reduction of Losses and Battle Damage" dated 12 February 1944

"Reduction of Flak Risk" dated May 1944



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F. The Location of Damage on a Heavy Bomber

(1) Flak, by far the most frequent cause of damage, obviously cannot be aimed at a particular part of an aircraft. In fact, when bombers are flying at high altitudes in a formation, the aim is at the formation, rather than at any single aircraft. Accordingly we might expect a random distribution of flak hits over the entire surface of a bomber. However, the shape of a flak burst together with the direction from which the projectile originates cause two distinct patterns in the distribution of flak hits on bombers:

a. Many more (up to 100% more) fragments strike a bomber from the lower than from the upper hemisphere, and the average velocity of hits from below is much greater than that of hits from above, many of which are spent. ---- This supports the conclusion that passive defense, such as flak curtains, should pay particular attention to protection from below, and that old type armor for the waist gun position which offered protection from the side but none from the floor, was ill advised.

b. More fragments (mostly flak, but also all kinds of flying debris, spent bullets, empty shell cases etc) strike the front of a bomber than any other part. The amount of punishment taken by all leading edges, nose glass, pilot's glass, de-icer boots, props, ring cowl and flat plate area of the engines is out of all proportion to the surface area exposed. When to this fact is added the results of enemy fighters nose attacks, an important principle is underlined, i. e. wherever possible, vulnerable equipment or key personnel should not be located near the leading edges; where such location is necessary the maximum possible protection should be provided against hits from the front. -----

2. Enemy fighter opposition leads directly to damage from rocket, cannon, and machine gun fire (and indirectly to self inflicted damage and hits from empty shell cases. When opposition is heavy, as much as 20% of all machine gun hits are friendly in origin and substantial damage is caused by waist gunners shooting up their own horizontal stabilizers) Analysis of the distribution of over 3000 enemy cannon and machine gun hits has led to the following conclusions:

(a) The remarkably even distribution of such hits over the surface of heavy bombers, together with the complete absence of any indication of clustering on the fuselage or on inboard parts of the wings demonstrates quite clearly that however the enemy pilots may be briefed to aim at particular parts of a bomber, they are unable to direct their aim with any such degree of accuracy. The part they hit is determined by chance. This suggests that our own gunners and fighter pilots, who sometimes have the idea that they should correct their aim off center, in order to hit some area they believe to be particularly vulnerable, - e.g. - a wing tank, should be carefully trained to try to center all their shots in order to maximize the probability of a hit.---



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(b) Examination of the directions from which our bombers have been hit by enemy fighter fire, when combined with other data, has proved to be extremely useful in obtaining a measurement of the efficiency of our gunnery, as a defense against attacks from different directions. When, for each clock direction, above and below, we matched the frequency with which our bombers were hit by enemy fighter fire against the frequency with which our gunners claimed to have hit attacking enemy fighters, the directions in which we had the greatest relative advantages and disadvantages quickly appeared. Our greatest relative advantage was found to be on low tail attacks, where the enemy is longest under our fire and on beam attacks where enemy fighters least frequently can hit us (presumably because it is their most difficult deflection shot) The B-17 was found to have a 7:1 disadvantage on low nose attacks and a 3:2 disadvantage on high nose attacks, but when the chin turret was added this disadvantage was reduced to about 5:4. It is also notable that no relative disadvantage on nose attacks existed for B-24's equipped with nose turrets. In general, however, the evidence suggests that the enemy had greater success against B-24's than against B-17's, and given the choice, would prefer to attack B-24's.

C. Recent Changes in the Relative Importance of Combat Risks

The most spectacular change in our defensive experience, and one which necessitates a number of major alterations in our tactics has been the change in the relative importance at our combat risks. This is evidenced by the following table:

| | NUMBER OF AIRCRAFT | | | | PERCENTAGE OF SORTIES | | |
|---|---|---|---|---|---|---|---|
| | Sorties | Lost | Damaged by E/A | Damaged by Flak | Lost | Damaged by E/A | Damaged by Flak |
| Jan-June 1943 | 4555 | 250 | 650 | 767 | 5.5% | 14.2% | 16.8% |
| July-Dec 1943 | 17,793 | 732 | 1314 | 3821 | 4.1% | 7.4% | 21.4% |
| Jan-June 1944 | 78,707 | 1617 | 1198 | 16756 | 2.1% | 1.5% | 21.3% |
| June 1944 | 25,922 | 233 | 47 | 4461 | 0.9% | 0.2% | 17.2% |

1. These figures show that from the first half of 1943 to the first half of 1944 there was:

a. A sharp cut in loss rates (from 5.5% to 2.1%)
b. A very much sharper cut in the rates of damage from enemy fighters (from 14/2% to 1.5%)
c. An increase in the rate of damage from flak. (from 16.8% to 21.3%.





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2. In June 1944, when many of our targets were tactical, the trend continued to the point where our losses were down to less than one per cent of sorties; our fighter opposition was negligible. (47 damaged on almost 26,000 sorties) but flak damage continued to be substantial (4461 or 17.2% of the sorties.)

3. The relative importance of the two major types of combat risks flak and fighters, which, in the last analysis, determines the defensive tactics which it is most advantageous to adopt, has undergone a most significant change. While, in the first half of 1943, damage was caused almost equally by flak (16.8%) and fighters (14.2%) and losses were overwhelmingly due to fighters (probably 80%), a year later flak was causing damage to 14 times as many planes as fighters (21.3:1.5%). By June flak caused almost 100 times the damage caused by fighters, and was estimated to be responsible for almost 90% of all combat losses.

The conclusions to be drawn are obvious; our measures against the GAF in the air and on the ground, the increasing size of our striking force, and the use of fighter escort, have succeeded for the time being in virtually eliminating the combat hazard from fighters, but much remains to be done in mitigating the risks from flak. Only by reduction of the flak hazard can further significant cuts be made in the costs of our operations.

Such reduction in flak risks can be achieved by adopting the following tactical principles as far as is operationally feasible:

(a) Careful routing and navigation to avoid passing over known flak defenses en route to and from the target area.

(b) Selection of the axes of attack and withdrawal, with consideration for the wind direction, to carry the force over the weakest part of the target defenses.

(c) Adjustment of the altitude of attack to the strength of the defenses, - with consideration for the relation of altitude to bombing accuracy.

(d) Planning the spacing and axes of attack of bombing units to make the fullest use of radio counter measures.

(e) Maximizing the spread in altitude and breadth, but not in trail, of the entire formation--(against barrage fire)

(f) Minimizing the length in trail, -- and the total time involved in crossing the target of the entire formation---(against continuous following fire)

(g) Minimizing the number of bombers flying together as a bombing unit.

In this connection it is notable that:



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(a) The Eighth Air Force has recently been bombing by squadrons of 12 instead of using its conventional 18-21 plane combat unit. Not only has this tended to reduce flak risks, but also it has been accompanied by an increase in bombing accuracy.

(b) In June the RAF conducted a number of shallow penetrations by daylight with its heavy bombers. A comparison of their costs with ours on attacks on similar targets shows that they suffered less than half the losses and flak damage; that we did, despite the fact that they attacked at generally lower altitudes. This is probably attributable to the fact that they flew a gaggle, while we offered enemy gunners the more attractive target of squadron formations.

H. Principal Causes of Loss and Remedial Measures

Based primarily on the cumulative evidence gathered from interviews of crew members of aircraft which were lost, several important lessons have been learned concerning the principal causes of loss and the directions in which we can find means to reduce them.

(1) Straggling - Protection of the Power Plant

The greatest defensive weakness of the B-17 consists of inadequate protection of the power plant.

Over 50% of our bombers which were lost were stragglers, -- generally made so because of damage to one or more engines.

Over 75% of our lost bombers had one or more engines knocked out.

Many of the losses could be prevented by the use of armor plate, up to the limits of permissable weight, to protect the engines. And since our experience shows that 11 men return wounded and 5 men return killed for every 10 bombers (100 men) lost, it seems reasonable to believe that the allocation of weight to passive defense would save more men and planes if it were concentrated on the power plant, than anywhere else on the aircraft. The only qualifications to this conclusion are that information is not available as to the extent to which armor plate to protect crew positions has proved of actual or psychological value.

(2) Fires and Explosions

When enemy fighter opposition was heavy, almost 2/3 of our lost bombers had one or more fires on them. At that time, the existence of fire and fear of subsequent explosion was the primary reason for most bale outs. Now that the fighter hazard is reduced, and since flak hits

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are less likely to cause fires, the fire hazard has diminished to the point where 42% of our lost bombers were on fire, and for 22% fire was the decisive cause of the loss. (20%, while on fire, suffered other damage which would have resulted in loss even if the fire had been extinguished)

The location of the fires points the way to the priorities which should be established in developing measures of fire prevention and extinguishment:

(a) 50% of the fires started within the engine nacelles, Both because of the high proportion of fires starting in this area, and because many of them later spread to the wings and caused explosions. It is clear that the highest priority should be given to the development and installation of the most efficient and extensive system possible to enable the pilot to extinguish fires starting in the nacelles. It is noteworthy that engine armor, already seen to be desirable on other grounds, would also serve as a preventive of the fire hazard.

(b) 15% of all fires, and the most quickly dangerous ones, started in the wings, tanks or fuel lines, and frequently caused explosions. Such devices which are under development by the British and at Wright Field as fuel tank purging with nitrogen or $CO_2$ and methyl bromide extinguishing systems offer hope that risks of this sort can eventually be checked.

(c) 10% of the fires, on B-17s occurred in the cockpit, almost always from cannon fire which simultaneously punctured oxygen bottlesand hydraulic fluid tanks. This hazard would be greatly reduced if a non-inflammable hydraulic fluid could be developed.

(d) The rest of the fires started at various points within the fuselage and generally could be extinguished with existing equipment.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By
1 Jan 75 PLS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

1 January 1945.

MEMORANDUM TO THE CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Abortive Sorties

1. Preliminary analysis of the operational records of the XX and XXI Bomber Commands, with particular attention to the frequency and causes of abortive sorties, reveals the following:

a. A higher proportion (74% of a/c airborne) of XX Bomber Command B-29s have bombed their primary targets than was the case for all targets bombed by B-17s and B-24s of the Eighth Air Force (66%) and Tenth and Fourteenth Air Forces (69%) at periods of comparable operational experience.

b. A lower performance has been recorded thus far on the major strikes of the XXI Bomber Command, which has had only 59% of a/c airborne bombing primary targets.

c. B-29s have had a higher incidence of early returns due to mechanical failures than B-17s and B-24s, with 16% of a/c airborne returning early from XX Bomber Command operations and 18% from XXI Bomber Command operations, as compared to 11% for Eighth Air Force and 7% for Tenth and Fourteenth Air Force operations.

d. These B-29 mechanical failures have been predominately associated with the power plant. 75% of the XX Bomber Command early returns and 76% of the XXI Bomber Command early returns have been due to engine, prop governor or turbo governor failures, swallowed valves, blown cylinder heads, excessive oil consumption, oil leaks, etc. An additional 10-15% of early returns have been associated with fuel transfer system difficulties.

e. The record on good weather days when visual bombing techniques could be employed shows that each of the B-29 Commands has had more than 75% of its airborne a/c bombing the primary target and 13-14% returning early because of mechanical failures.

f. On bad weather days, where bombing had to be done by radar, results have been disappointing. XX Bomber Command has had 55% of a/c airborne dropping bombs in the vicinity of the primary and 22% return early for mechanical reasons. XXI Bomber Command has reported only 30% as bombing the primary and 31% returning early due to mechanical failures.

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2. Supporting tables and interpretive text follows;

In attempting to assess the abortive rates of B-29s, particularly in comparison with similar data from other Air Forces, several circumstances must be kept in mind. A true comparison could be made only if the different Air Forces were flying the same aircraft under similar conditions, through similar weather, with the same frequency, and with the same level of experience, and comparable records must be kept. I.e., major variables affecting the abortive rate may be expected to be:

a. The "tenderness" of the aircraft.

How susceptible is it to mechanical breakdown? Is it debugged yet? Early experience with B-17s showed large numbers of abortives caused by supercharger failure (later remedied by the electronic supercharger and by the development of better discipline on the permissible engine settings on the climb) and by oxygen system failures (remedied by a PEO campaign and by the installation of the demand-type oxygen system.) Such early B-29 problems as over-heating engines and blown blisters are being remedied but the records show that the power plant is still subject to all too frequent breakdown in B-29s, and that improvements are probably needed to reduce the number of fuel transfer failures.

b. The frequency of missions.

How frequently are aircraft dispatched on operational missions? Is maintenance leisurely or hurried? Are facilities and personnel strained by the necessity of conducting missions in rapid succession? Eighth Air Force records show that whenever missions were run on successive days or with great frequency, even apart from aircraft grounded for repair of battle damage or maintenance, the size of the effective striking force was sharply reduced by a large number of early returns. Similar strain may be expected with B-29s, and it is reasonable to assume that the XXI Bomber Command will have a higher abortive rate because it will be operating more frequently than the logistically limited XX Bomber Command. This increase in abortives can be ascribed both to the extra pressure and fatigue on the part of ground crews, and to the strain on flying personnel which will tend to affect the judgment as to the appropriate circumstances under which to abort.

c. The level of experience of ground and flying crews.

How well trained and how experienced are maintenance and flying personnel? Many failures to bomb the primary target occur

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because of faulty navigation, unsuccessful target identification or personnel error, and many early returns are attributable to faulty maintenance. In the early months of a new Command, inexperience can be expected to cause many such failures; as experience is gained, they tend to decrease. It is notable that in its first 11 months of operations the Eighth Air Force had 33% of its a/c airborne fail to bomb any target, and 13% was early returns due to mechanical breakdowns. Recently these figures have been reduced to about 20% and 4% respectively. We should be able to expect similar improvement in B-29 operations, - if proper attention is directed to the problem. Indeed, the superior record of the XX Bomber Command, as compared with the newer XXI Bomber Command, already give evidence of such improvement.

d. The weather conditions under which operations are conducted. How often are operations conducted under less than CAVU conditions? How successful are weather forecasts? It is platitudinous that weather dominates air warfare. Probably no other single factor has such great influence on the effectiveness of a strategic air force. In addition, however, to the grounding of aircraft on bad weather days, weather has many significant direct and indirect effects on the abortive rate. ETO experience (with 15-20% of sorties abortive because of weather) shows, and B-29 operations have already confirmed the fact that, when bad weather is encountered, whether because of a missed forecast or because of a planned blind bombing mission, difficulties in assembly, early returns because of weather that cannot be penetrated, missed escort, and failure to find the target, have sharply reduced the number of aircraft bombing the primary target. (This is apart from the notorious decrease in bombing accuracy on overcast targets). A further significant fact is that the number of early returns for "mechanical reasons" rises sharply on bad weather days. It can be conjectured that the increase of such failures attributable partly to the effect of turbulence and high winds in straining engines, and partly to a subjective decision on the part of the airplane commander to turn back with less extreme provocation than would be the case on good weather days.

e. The extent of enemy opposition and our defensive tactics. How much of the failure to bomb the primary is due to losses, to missed formation, to the return of spares? In Theater where opposition is heavy, certain additional circumstances have had the effect of increasing the abortive rates. By definition, any aircraft presumed to be lost before reaching the target is an abortive in the sense of having failed to bomb. Moreover, when the amount of



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opposition dictates the necessity of a balanced formation, both unused "spares" and aircraft which failed to assemble are classified as abortive. The extent to which these types of abortives will be of importance in overall abortive rates will vary according to ehemy capabilities and Command policy.

f. The form in which abortive records are kept.

How is an abortive defined? How are the causes of abortives ascribed? Variations from Command to Command make it difficult to secure comparable data. For instance:

(1) A strict interpretation would require that the basic measure of efficiency is the proportion of a/c airborne which bombed the assigned primary target. All others might properly be counted as abortive. Such figures are kept for the Twentieth Air Force Commands. The figures available for the Eight, Tenth and Fourteenth Air Force, however, count as abortive only those a/c airborne which failed to bomb any enemy target, including secondary targets and targets of opportunity. Since the Eighth Air Force was forbidden to jettison over occupied territory, most bombing was done on primary targets.

(2) Uncoordinated subjective decisions are involved in classifying many early returns which could be interpreted either as mechanical failure or personnel errors.

(3) The descriptions of causes of mechanical failures are frequently so vague or incomplete as to defy classification in such detail as to point the way to remedial measures.

(4) The unique problem of flights from rear to forward bases prior to XX Bomber Command operations, and its influence on the missions themselves cannot be compared with other Air Forces.

(5) Measuring abortives against aircraft airborne puts a premium on the decision not to mount the maximum force, and fails to indicate the success of maintenance personnel in keeping aircraft operational.



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Memo to Chief of Staff, Twentieth AF 1 January 1945

3. With these cautions in mind lest too much be read into the figures, three tables follow:

a. Table I shows the percentages of a/c airborne which bombed the primary target, other targets, and all targets, which failed to bomb and which returned early because of mechanical failures. The data cover the first 19 missions of the XX Bomber Command, the 7-14th missions of the XXI Bomber Command, and the B-17 and B-24 missions during the months of April-June 1943 of the Eighth, Tenth and Fourteenth Air Forces.

TABLE I

Comparative Abortive Rates, Early Operations. HB and VHB

| Percentage of A/C Airborne which | XXBC % | XXI BC % | 8th AF % | 10 & 14AF % |
|---|---|---|---|---|
| Bombed Primary Target | 74 | 59 | --- | --- |
| Bombed Secondary or Other Target | 15 | 23 | --- | --- |
| Bombed some Enemy Target | 89 | 82 | 66 | 69 |
| Failed to Bomb Primary Target | 26 | 41 | --- | --- |
| Failed to Bomb Any Enemy Target | 11 | 18 | 34 | 31 |
| Returned early due to mechanical failure | 16 | 18 | 11 | 7 |

b. Table 2 shows the chief causes of mechanical failures reported to have resulted in early returns. Because of variance in reporting procedures, no further break down of the data is significant. Included within the category "power plant failures" are such items as "engine failure", "engine ran rough", "engine internal failure", "swallowed valve", "cylinder head blown", "engine fire", "oil leak", "excessive oil consumption", "prop governor failure", "prop stuck", etc. The figures shown are percentages of the total number of mechanical failures on aborting aircraft for which reports are presently available. This covers 202 cases occuring on missions 3-19 of the XX Bomber Command, 78 cases occuring on missions 8, 9, 10, 11, 13 and 14 of the XXI Bomber Command, and 236 cases tabulated on 10 missions conducted during May and June 1943 by the Eighth Air Force.

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TABLE 2

Chief Causes of Early Returns Due to Mechanical Failures

| Percentage of Mechanical Failures Associated with | XX BC % | XXI BC % | 8th AF % |
|---|---|---|---|
| Power Plant | 75 | 76 | 59 |
| Fuel Transfer System | 10 | 15 | -- |
| Oxygen System | -- | -- | 12 |
| Other Causes | 15 | 9 | 28 |

c. Table 3 represents a sample tabulation designed to show the differences in the abortive rates on good weather days as compared with bad weather days. Included in this tabulation are the following missions:

| Visual Bombing | | | | Radar Bombing | | | |
|---|---|---|---|---|---|---|---|
| XX BC | | XXI BC | | XX BC | | XXI BC | |
| #8 | Anshan | #10 | Tokyo | # 9 | Anshan | #8 | Tokyo |
| #13 | Omura | #12 | Nagoya | #16 | Omura | #14 | Nagoya |
| #19 | Omura | #13 | Nagoya | #17 | Omura | | |

TABLE 3

Comparative Abortive Rates, Good & Bad Weather Days

| Percentage of A/C Airborne Which | Visual Bombing Missions XX BC % | Visual Bombing Missions XXI BC % | Blind Bombing Missions XX BC % | Blind Bombing Missions XXI BC % |
|---|---|---|---|---|
| Bombed Primary Target | 78 | 76 | 55 | 30 |
| Bombed Secondary or Other Target | 11 | 12 | 30 | 38 |
| Bombed Some Enemy Target | 89 | 88 | 85 | 68 |
| Failed to Bomb Primary Target | 22 | 24 | 45 | 70 |
| Failed to Bomb Any Enemy Target | 11 | 12 | 15 | 32 |
| Returned Early Due to Mechanical Failure | 13 | 14 | 22 | 31 |

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4. In view of the preceding, what conclusions can be drawn?

Current abortive rates of the B-29 Commands should not be the source of discouragement. Indeed they compare well with similar figures for other Air Forces during their developmental stages. However, as time went on other Air Forces' records improved, - and not without effort. Accordingly, it is imperative that similar efforts be expended within the Twentieth Air Force in order to achieve the maximum efficiency of which B-29 operations are capable. In the light of the preceding analysis of the causes of abortives, it appears that the greatest reductions in abortives should be attained by attention to the following problems, - and it is recommended that appropriate steps be taken to insure that all possible remedial measures be employed:

a. To reduce abortives induced by bad weather, - it is recommended that every facility be accorded the Weather Officers in order that the reliability of forecasts can be improved. Even if this involves the diversion of aircraft from bombardment to reconnaissance, it is demonstrable that it would pay for itself many times over. In addition, consideration might be given to the employment of "look-see" weather pathfinder aircraft to precede the main striking force and to direct them to targets which are open.

b. To reduce abortives caused by faulty navigation and unsuccessful target identification, aggravated by bad weather, - it is recommended that every care be given to the selection and special training of lead crews. Since the ultimate success of a mission is made or broken by the leaders, too much attention cannot be paid to means to insure superlative leadership. Difficulties encountered on missions to date indicate that great returns would come from increased emphasis on DR navigation, and radar-offset techniques.

c. To reduce abortives associated with mechanical failures, - it is recommended that a review be conducted in the field of the numbers and competence of maintenance personnel, that analysis be made of the particular failures which most frequently cause early returns and that special inspections and drills be held on the relevant

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types of maintenance. Also, it would appear desirable to query the Commands as to the details of fuel transfer system failures in order to determine whether they are due to faulty maintenance, or to an inherent remedial defect in the equipment.

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of
The Commanding General
Army Air Forces
23 Jan 45 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

23 January 1945

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: A Note on the Frequency of Aborted Missions with B-29 Aircraft.

1. This is an interim note, provided because

a. currently available data significantly reinforce earlier indications which already have been made the basis for recommendations concerning the inadequacy of the B-29 power plant and

b. because an inquiry is suggested which it is desirable to continue as vigorously as possible in two main directions, namely:

(1) the examination of the performance of B-29 aircraft under the various conditions of their use

(2) the study of the performance data of the several groups in each of the active Bomber Commands.

It is realized that the presently available information is in some respects imperfect; at the same time certain general conclusions are temporarily permissible, and they seem to point to a desirable course of action.

2. The conclusions suggested by this examination of the data on abortive missions are:

a. The percentages of abortive missions of B-29 aircraft in XX and XXI Bomber Commands have tended to rise slightly with time,

b. The proportions are not significantly different in XX, XXI Bomber Commands, and domestically in Second Air Force training area. Nor is there any real evidence of improvement with time since last Summer, anywhere.

c. The highest proportion of responsibility for these abortive missions is most significantly a matter of the engine and its immediate accessories ("power plant"), and is not a fundamentally a function of theater of operation or of experience level in operating crews. It is essentially the result of what has been built into the airplane.

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d. Certain differences appear in the records of the four groups of XX Bomber Command.

e. Improvements attempted with respect to the B-29 power plant have to be evaluated with reference to mission performance. The criterion here considered is the proportion of "abortives" - defined as either not bombing the primary target, or (domestically, in Second Air Force) not completing an assigned training mission. The institution of rational "quality control" of performance with respect to getting over the target and dropping bombs on it is basic to the improvement of details of bombing technic. It is therefore urged that the most careful, active attention be given to examination of the activities of B-29 aircraft and crews in the special project area where at least certain of these matters can be examined more realistically than at Second Air Force bases. No data from this area are thus far available; the opportunity to scrutinize this situation should not be lost; it should be carefully exploited, as soon as possible.

f. The high rate of failure of flight instruments in operational B-29 aircraft in combat areas has been noteworthy. Separate attention has been called to the fact that this type of failure is curious and important. There does not appear to be a significant excess of instrument failures in domestic B-29s as compared with B-17 or B-24s. Yet in the combat areas the failures of tachometers and temperature gages are altogether too high. It is important that this be examined in the area referred to in "e" above.

3. A summarization of the data:

a. In Second Air Force training area, during Dec 44, 2,091 B-29 sorties were flown from Second Air Force Bases in United States; 32 per cent of these were abortive, 14 per cent of the missions being abortive for "power plant" reasons; the percentage abortive for "mechanical failure" reasons was 27.5; the percentage of "mechanical failures" chargeable to the power plant was 50.9. This is exactly of the order observed in data from XX and XXI Bomber Commands. In this general period overseas, the percentage of abortives has been for XX Bomber Command, 23.8 per cent increasing to 29.3 per cent; for XXI Bomber Command 21.2 per cent; the percentage of "mechanical failure" chargeable to the power plant, between 45 and 90 per cent. In XX Bomber Command the percentage not carrying out mission of bombing primary target has been 36 per cent, 16 Oct to 14 Dec 44; in this period, something like 15 per cent of the missions were abortive, by the present definition for reasons laid at the door of the "power plant." In XXI Bomber Command, same period, roughly 40 per cent of airborne aircraft were on the average abortive by the definition used, and indication is that something like 18 per cent aborted for "power plant" reasons. There is every indication here that a "built-in deficiency" has been responsible, is being responsible, for this condition - regardless of whether the plane is flown in the United States on training missions, or from China, India or Saipan against the enemy.



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b. In Second Air Force territory, during December 1944, with
B-29, 32 percent of missions were abortive,
14 percent assigned to "power plant"
B-17, 10.5 percent of missions were abortive,
2.7 per cent assigned to "power plant"
B-24, 23.4 per cent of missions were abortive,
7.0 per cent assigned to "power plant"

These indications agree qualitatively with results in overseas data, and in essence they agree quantitatively.

c. During Missions 3-10 inclusive of XX Bomber Command, and in the subsequent period, the percentages of abortives (as earlier defined) appear as follows in the four constituent Groups:

Percentage Abortives, Average

| Groups | Missions (3-10) | (10-20) | (24-28) |
|---|---|---|---|
| 40th | 18.6 | 28.2 | 32.7 |
| 444th | 21.4 | 24.1 | 22.6 |
| 462nd | 21.7 | 26.2 | 22.6 |
| 468th | 30.7 | 29.4 | 27.7 |

It seems that, although the differences are not very great, a real suggestion is obtained that there has been, for seasonal or other reasons, a trend toward over-all worsening of performance as regards abortives. The figures are based on aircraft air borne from forward Bases; breakdown as to "causes" is not attempted here, but it is possible to suggest that one Group has been progressively more unfortunate, another has not changed very much, while the other two have not deteriorated in effectiveness (with reference to the present criterion of abortives, only). While it might be valuable, and will be increasingly valuable in the future, to investigate the reasons for even such slight differences as are suggested in this table, these are of lesser import at the moment that the outstanding factor of inadequate mechanical ruggedness of engine, fuel system and accessories, and specifically of power plant competence, in retarding the effective use of B-29 aircraft.

W. J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

17 March 1945

MEMORANDUM TO DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Safety and Efficiency, A/C Operation

1. It is becoming very clear that one of the ways in which military efficiency in the use of B-29 aircraft can be most effectively increased is by the careful institution of an educational campaign, in the theater of operations, for air crews and ground crews. Examination of available data shows a high rate of abortive mission sorties. This rate shows a curious and impressive statistical stability. It is, roughly, one half due to mechanical difficulties of one oranother kind; one half of this, that is, one quarter of the total, involving the power plant.

2. The power plant, like other operated features of the airplane, does not function automatically. It is used, controlled, adjusted, by men. In this respect, a campaign, a definite program such as Major Swain has outlined in a recent memorandum, could be of very great value. This program stresses not so much "safety" as competence and efficiency in operating procedures, with with objective criteria for judgement of men. Or quite apart from the fact that this particular program may or may not be the ideal one at the present time (I am not competent to judge as to that), it is a definite plan.

3. This plan cannot be fully evaluated unless it is examined in the light of theater conditions. It cannot be improved without a first-ahnd understanding of relevant circumstances under combat theater conditions.

4. It is strongly recommended that Major Swain should be enabled to study, very soon and at first ahdn, at XXI Bomber Command bases the actual current conditions of B-29 combat operations, with reference to "ground safety" and particularly "flying safety." The term "safety" has been overworked. The objective is smooth, efficient operation without mishaps, aobrts, losses.

W. J. CROZIER
Operations Analyst

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2 April 45

MEMORANDUM FOR : DR. ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

Subject : B-29 Ditchings

1. Three Ditching Reports from 313th Wing (Nos. 2, 3, 4, attached herewith), have been studied, in consultation with Mr. Hooker; he has made abstracts of certain points for transmission to you, together with his corrective suggestions.

2. Several specific points may be commented upon:

a. In Report No. 2 it is not considered safe to take up the position assumed by Radio Operator - "kneeled on the lower forward turret with his head braced on the upper turret, facing forward"; if turrets dislodge, as can happen, Radio Operatorcould be pinned and crushed.

b. The selector valve Report No. 3 is badly placed. Could it be moved to a site more favorable for manual operation? Could a better handle be provided for use in emergencies of this kind?

c. Axing the astrodome is very inefficient (Reports 3,4), as when freed it drops inward. Question: Is there a problem of "tropicalization" involved in the sticking of the dome after the tab is pulled? - for example, does Zinc chromate packing attack the plastic of the dome? I am informed the $CO_2$ from an extinguisher can be directed on the dome, thus chilling it severely and making its removal much easier as result of shrinkage. In all three of the present cases, difficulty was experienced with the astrodome.

3. Several more points are noteworthy:

a. There has not been sufficiently enforced adequate training in ditching procedures.

b. Insufficient attention has been given to the critical evaluation of the worth of survival equipment and of inadequacies in its usefulness. There should be much better and more frequent inspection of the arrangement and stowage of survival equipment. The

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problem of oars for rafts, water canteens, flashlights, seem not to have been properly foreseen. It is shocking that the problem of the too heavy E-5 kit had not been dealt with in advance.

W. J. CROZIER
Operations Analyst

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FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

12 January 1945

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Survival Equipment for Ditched Crews

1. In the excellent reports on two recent ditching operations (B-29's 42-63432 and 42-65245, XXI B.C.) a point emerges to which attention should be given - the inadequate quality of the survival equipment. Items mentioned by the rescued men include:

a. Oars too fragile.

b. Loops at sides of rafts and oarlocks not adequately fastened to the rafts.

c. Rations and first-aid supplies were in cardboard containers, not water-resistant.

d. Water cans, and marker cans were dented.

e. Insufficient rope was available, and it "rotted" in the water.

f. Sea anchors were too small.

g. The dinghy radio should be better waterproofed.

h. Containers for radio and accessories were packed with paper and excelsior; space and weight could be utilized by packing with useful articles (b.g., tarpaulins)

i. Fishing gear - hooks, harpoon - were found too light to deal with fish present; and hooks corroded.

j. Compasses were not water-proof.

k. One E-1 Emergency Kit had been installed (Arctic Survival-complete with ice creepers)

2. It is suggested that an attempt be made to obtain further information as to the quality of survival equipment installed in B-29's

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particularly in aircraft of XXI B. C.; and that better inspection of this equipment be undertaken; and that further consideration be given to the problem of the efficient storage of the equipment, with reference to ease of its removal to rafts.

3. The use of shoulder-straps for pilot and co-pilot in one of these ditchings should be further studied. So also should the suggestion that an emergency manual device be installed to assist in raising bombay doors (e.g., a cable, as mentioned in the Report, worked on the bomb hoist).

W. J. CROZIER
Operations Analyst

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3 Mar 45
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MEMORANDUM FOR: DR. ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

Subject: Survival Equipment for Ditched Crews (B-29)

1. The memorandum of 12 Jan 45 on this subject was written to give a condensed statement of certain reported difficulties. It is known that material has been improved, and that better T.O.'s have been provided. It is not all certain, however, that improved equipment, such as I have been able to examine at Wright Field, is actually being installed in planes in combat theaters. For sometimes it has seemed desirable that something in the way of "performance control" be instituted with reference to Personal Equipment in general - and survival equipment especially.

2. A further, more recent, Ditching Report has been received, under date 31 Jan 45, of Mission No. 7 of XXI Bomber Command (73rd Bomb Wing, 24 Nov. 44; A/c 42-24679).

a. Four men floated about for up to four hours in darkness before being picked up by 8 others in 2 rafts. It was suggested that "it would be an excellent idea to have a flashlight attached to the Mae West so that people lost at night could be spotted".

b. Four men had difficulty in inflating Mae Wests. The $CO_2$ release did not puncture the cylinder although "the top was screwed down tight".

c. Hydrogen generators leaked as the raft was tossed by the swell, so that the balloon for the Gibson Girl antenna could not be inflated.

W. J. CROZIER
Operations Analyst

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8 March 45
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MEMORANDUM FOR: DR. ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

Subject: Conference with Naval Men Regarding Rescue of Ditched B-29 Crews.

1. At Colonel Brown's request I met with Mr. C. Kittel and Mr. J. Pollam of Navy Operations Analysis Section (Navy Ext. 5185) to discuss failure of ditching rescues attempted by submarine. I was impressed by the fact that these Navy men, and Dr. Shockley, who was with them, were completely uninformed as to the nature of B-29 ditchings - what happens when "normal" ditching is possible, what survival equipment may be available, the difficulties presented by night crashes, and by forced ditchings close to Japan.

2. Discussion brought out the fact that a major difficulty lies in the totally inadequate radio communication from the submarines. I therefore suggested that attention be focused on improving this radio sending - by use of the corner reflectors, by use of FM perhaps, and by other means if suitable.

3. It was also suggested that this subject is so important that a concerted effort should be made to give it unity of direction. An organizational unity is necessitated by the fact that so many Army Air Force and Navy components are required to work together in harmony. This thought was communicated to Colonel Brown; he approved the notion and suggested that Guam was the place to do it, since representatives of the units concerned are located there.

4. A difficulty lies in the fact that Navy is said to not be really interested in this use of its submarines, and does not wish it known (of course) that they are so used.

5. It seems desirable that, since there is, I believe, no one in XXI Bomber Command Operations Analysis Section who has worked with the FEO's and other units actually concerned, Mr. Goddard be requested to organize a Board, or working committee to coordinate the rescue situation as it involves the attempted use of submarines, and to discover directions of improvement. I understand that only one of twenty "tries" has been successful, and that one because the men in the dhingy spotted the submarine rather that the toher way 'round.

W. J. CROZIER,
Operations Analyst

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25 Nov 44

MEMORANDUM TO: Dr. Robert L. Stearns, Chief
Operations Analysis Division

SUBJECT: B-29 Performance, and "Accidents" in the Theater of XX Bomber Command (Letter from Dr. Jeffers).

1. Fuel consumption data for analytical purposes should be based on measurements with flow meters on the individual engines, since these will differ in gasoline consumption in a single plane. I have been informed that a very real factor in differences from engine to engine has been found in the performance of the carburetor and of a valve spring which it contains. (It would be useful to know whether the gasoline consumption of outboard engines is in excess of that of the inboards in view of their use for "jockeying" during formation flying).

2. The "accident" data listed are already known, I believe, at least in greater part. No date span is given with reference to them. From the total of 74 should be subtracted certain of the items listed if the intrinsic properties of the plane are to be considered. Taking away "Fuel exhausted" (13), "Crashed, no details" (10), "Missing - no report" (6), and "Enemy Action" (2), and also "ground fires" (3), we have a residuum of 40 "accidents" in this list - which still includes 5 "crashed on take-off - no details". Of these 40, 18 are listed as "engine failure" - 45 per cent of the 40 cases. Among the 18 engine failures, 8 are listed as "engine fire" - 44.5 per cent - a not unreasonable figure in the light of other experience. The "crashed on take-off - no details" (5 instances) probably included several engine fires, if other experience is a proper guide; but if these 5 are subtracted from the 40 (to exclude instances where no positive information is available) we have 8 out of 35 instances with specification in which engine fire was recorded - 22.8 per cent.

3. Bearing in mind that the probable occurrence of engine fire at take-off has been masked in Mr. Black's table, this figure corresponds closely to the relative frequency of engine fires in general experience with B-29 aircraft.

4. Much fuller data are required for study of B-29 troubles overseas, if use of them is to be made for guidance toward corrective measures. There are certain maintenance factors which should operate to produce better performance of B-29 aircraft, in the combat theatres, than in the domestic area: the better spirit of maintenance crews, and longer average periods between flights when the work can be done. But it is not without interest that despite these influences the proportion of engine failures among "accidents", and among these the fraction of engine fires, is about the same domestically and overseas; this has been pointed out already in a report on B-29 engine fires.

W.J. CROZIER,
Operations Analyst

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HEADQUARTERS
XX BOMBER COMMAND
Operations Analysis Section
APO 493

16 November 1944.

Dr. Robert L. Stearns,
Chief, Operations Analysis Section,
Twentieth Air Force,
Room 4D154, The Pentagon
Washington 25, DC

Dear Dr. Stearns,

In answer to your Telecon No. 14-8, we are sending the Memorandum on Fuel Consumption of the B-29, and also one on B-29 accidents, both written by Mr. Black.

These were prepared some time ago, but they were not sent to you because I considered them unacceptable. Joe Black is firmly of the opinion, though, that under the existing situation as to the collection of accurate fuel data, nothing better can be done.

In the near future flow meters will be installed in operational planes, and a quantity of more accurate information will then become available.

Also in the near future, we shall have the services of Mr. Berger, who is, perhaps, more analytically minded than Mr. Black. The fuel problem will be turned over to him, and perhaps he will be able to extract more useful data from the imperfect material at hand.

In the meantime, for logistical planning, the fuel consumption figures given in the revised B-29 Handbook will be adequate.

Yours sincerely,

HAMILTON M. JEFFERS
Chief, Operations Analysis Section

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MEMORANDUM REGARDING FUEL CONSUMPTION OF B-29 AIRCRAFT
IN THE XX BOMBER COMMAND

Accurate records of fuel consumed by B-29 aircraft here are practically non-existent. With one or two exceptions all missions have been staged from the forward (China) bases. Personnel is not available to check all aircraft immediately on their return from the missions because of the necessity of getting the planes out on their return to India as soon as possible. Approximations are made by sticking the tanks or from the logs of engineers. The flexible self-sealing cells installed in the plane do not permit any great degree of accuracy when sticking tanks that are nearly empty. Readings below five hundred gallons per tank cannot be relied upon. The fuel quantity gauges are completely unreliable. The best method found so far is to transfer all the fuel to one tank immediately after landing and stick that tank, but as previously stated sufficient personnel is never available. The crews are immediately taken away for interrogation and ground personnel is hard pressed to put all possible aircraft in flying condition as soon as possible, let alone having time (one half to three-quarters of an hour) to spend on transferring fuel. Also fuel is at such a premium in the forward areas that equipment necessary (auxiliary power units and pump fuel meters) have not been carried forward.

Such figures as have been obtained indicate a consumption of 1.95 to 2.2 gallons per mile on the average mission. No missions have been run completely at night, and no extra consumption has been noted.

Tactical advantages gained require altitudes much in excess of those desirable for maximum range. In other words, range is always sacrificed for altitude. The cost of lifting the loaded planes has proven to be close to that predicted by the climb charts. However, again, it is not known exactly how close. Policy has been to remain as low as possible for as long as possible.

Formation flying increases fuel consumption notably. At the start a four plane formation required ten to fifteen percent more fuel than individual planes for the same distance. Now, with more practice, it is felt the figures can safely be reduced to around seven percent. Twelve plane formations still cost more than ten percent, but is hoped that with more experience this figure can be reached.

To date the limit factor for bomb loads is the take-off gross weight, and indications are that it will remain so until 140,000 pounds gross weights are exceeded. There has been considerable discussion as to the variation between planes and between crews. So far satisfactory explanation for these variations has not been made, and the best practice seems to be to grade planes and crews on past performance. The better performing units are assigned heavier weights and smaller reserves. Pilot technique plays an important part particularly here where density altitudes are consistently 2,500 to 3,500 feet over pressure altitudes, and engine cooling is always a severe problem.

JOSEPH B. BLACK

October 1944.

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MEMORANDUM REGARDING ACCIDENTS OF B-29 AIRCRAFT IN THE XX BOMBER COMMAND

It is not possible to secure a complete report of B-29 accidents, but of 74 recorded the distribution was as follows:

| | | |
|---|---|---|
| 1. | Engine failures | 18 |
| | Engine on fire - 8 | |
| | Propellor wouldn't feather - 2 | |
| 2. | Fuel exhausted | 13 |
| | Navigation error - 2 | |
| 3. | Crashed, no details | 10 |
| 4. | Landing gear failure | 8 |
| 5. | Missing - no report | 6 |
| 6. | Crashed on take-off - no details | 5 |
| 7. | Pilot error | 5 |
| 8. | Ground fires | 3 |
| 9. | Accessory failure | 2 |
| 10. | Brake failure | 2 |
| 11. | Enemy action | 2 |

In cases where there was more than one trouble experienced, the accident was charged to the factor considered most liable. Probably several of the aircraft listed as "missing, no report" and "crashed, no details" could be charged to enemy action.

JOSEPH B. BLACK

October, 1944

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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NOTE FOR INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS SECTION, SECOND AIR FORCE

Subject: Note on the Term "Accident".

1. With reference to aircraft operation the term "accident", borrowed originally (on suspects) from civil airline practice, has come to have a mixed connotation. By definition in AAF Regulation 62-14:

"8. Aircraft Accident

An event involving one or more military aircraft

a. That occurs while:

(1) the aircraft is engaged in any phase of serial flight including take-off and landing runs, or,

(2) the aircraft is being taxied, or,

(3) the aircraft is on the ground and the power plant is in operation, except maintenance operation; and

b. Which results in:

(1) death or major injury to person or major or more extensive damage to the aircraft, or,

(2) minor injury to persons or minor damage to the aircraft."

Exceptions specified include repair or replacement of parts, system, or assembly necessitated by wear and tear or by malfunctioning resulting in operating failures where such repair or replacement is the sole damage. "Major damage" and "minor damage" are also defined.

2. The application of this definition of "accidents" leads to certain decisions which, from the standpoint of the organic problem of safety and efficiency in aircraft use, have a somewhat arbitrary character.

3. If an aircraft noses up (engine running, aircraft stationary, jumps chocks) it is officially an "accident" if the Flight Crew is in control of the airplane, but it is not an "accident" if maintenance personnel are in charge while servicing, repairing, or inspecting the aircraft. Again, a stationary aircraft, in a parking area, may be run into by a truck; it is not an "accident" unless the engines are operating under control of Flight personnel.

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4. Thus, in addition to the logical difficulties inherent in the use of the term "accident", arising from the persistent notion of a chance association of causes in the production of an unwanted event, there has been introduced a further complication. The reasonableness of this is in one sense clear, since for Air Force purposes it is desirable to consider separately those unwanted events which are specifically concerned with the operations of the airplane in or connected with flight - that is, when in the hands of the Flight Crew. Yet it is pretty clear that there would be a real advantage if a fresh terminology could be found.

5. The purpose of the investigation of unwanted events is primarily to prevent their recurrence, rather than to assign blame and to apportion reproof and punishment. In common understanding an accident is an event or happening which takes place without being expected or planned for; hence, the conception is strongly tinged with the notion of sheer change, or mere contingency. There is nothing in all this which excludes from the category of "accidents" favorable happenings of an unplanned, fortuituous nature; yet airplane accident analysis has scarcely been concerned with such occurrences, interesting and suggestive as they sometimes might well be. In Air Force practice an accident is an undesired, damaging event which occurs while the engine or the engines are running and the aircraft is under the control of the Flight Crew; the notions of chance occurrence or of contingency are included; the usual conception of "accident" in law (equity) as an unexpected happening not due to negligence or malfeasance on the part of the individual or individuals concerned is therefor greatly enlarged, because errors of omission and of perpetration as well as inadequacies of judgment by members of Flight Crews which result in damage are recognized as causes of "accidents".

6. For military purposes the aim is to reduce the occurrence of unwanted, unexpected, damaging events involving aircraft and personnel, since when such things occur, effectiveness is reduced. A basic consideration is the necessity of recognizing that safety, the absence of "accidents" however defined, is for practical purposes synonomous with efficiency of operation. This has been the view of the Second Air Force AAC and especially of its former Committee on Flying Safety. To increase safety it is obligatory to eliminate damaging unwanted events; this can be done only to the extent that the physical nature of such events is understood. In such cases it is no longer possible to invoke mere chance or contingency.

7. Consequently, what is needed for descriptive purposes is a general label which will tend to focus attention upon the nature of unwanted, damaging occurrences with aircraft, and at the same time definitely suggest the real objective of dealing with them. The term "accident", now used in this connection, suffers from the difficulties always found when old words are, in effect, re-defined in a special way.

8. The disadvantages are of several kinds, and they are of real, practical significance. Perhaps most important is the hinderance to safety education among Air Force personnel, resulting both from the

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feeble connotations inescapably associated with "accident" and from the absence of an objectively meaningful label for the general class of unwanted occurrences.

9. A second disadvantage is that the statistical analysis of these events can be in certain cases misleading unless Ground Safety data (that is, concerning incidents in which the airplane is in the hands of Ground personnel) are combined with the regular "Accident" data. For still other cases the limitations of the reporting system introduce notable deficiencies. Thus, if a plane with engines on fire is successfully landed without injury to crew or without buring through the nacelle, the occurrence does not appear in the Accident Report. Yet information on such happenings may be of vital significance for the evaluation of more serious events. Such omissions are a consequence of the arbitrary official definition of "Accident". Similar troubles arise from the operationally defined term "crash" or "crash landing".

10. What is needed, then is a more objective, realistic, terminology for the classification of unwanted, damaging or potentially damaging happenings during the use of aircraft. This should provide for the inclusion of data on "near accidents", as they are sometimes called - events which might have been more or less disasterous if they had fully developed in certain directions, but which by crew skill or good fortune did not grow in that way. It should avoid the term "Pilot error", unless this can be carefully defined by use. And it should recognize that a particular type of "accident", say an engine fire of a specific kind, might well be in one instance the outcome of poor management by the Flight Crew, yet in another instance the result of specific structural deficiency; while in every case the use of the aircraft involves at every moment an interaction between human beings and the mechanisms of the airplane. If the nature of these mechanisms is such as to impose a hazard in use, human deficiencies will only serve to accentuate the basic risk. The point of analysis of the results of such risks is to reduce the probability of inadequate interaction between the Crew and the mechanisms they use.

11. It is not easy to contrive an objective terminology for this purpose, and the current use of "Accident" has become pretty much a habit. Yet the analytical advantages should be worthwhile if one could be found. So also, it can be suggested, should the advantages to teaching crews an objective attitude with respect to untoward events in flying. "Accident" inescapably carries an aroma of chance, "Act of God", and the like. In the sense of contingency it may well be strictly a matter of the cooperation of multiple causes, chance, that a given event happens to occur at a particular moment, but this aspect of the matter may have little significance for a campaign to reduce the frequency of such events. Here, the recognition of ways to effect this desired reduction is the important matter.

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12. Hence it has been suggested that a word signifying "fault" (although this word itself often implies blame, in a personal sense) might well be used. The geologist uses it to signify an abrupt physical break in an otherwise continuous earth-layer. With respect to aircraft operation, a fault is an abrupt interruption to desired performance. From a not-too-wide view, a structural fault in the aircraft is somewhere, at some stage, the result of imperfect performance by engineer, designer, craftsman - a "fault" that is, with respect to the intention to produce an airplane with certain specified properties. At every stage the interaction between the men and the machines is continuous, so that even the tinge of "blame" need not require us to discard the term fault. It has the advantage that a "fault" is rather implicitly something which can and should be corrected.

13. An airplane encountering a sudden storm may go down. It does not help greatly to lay this to "accident"; from the standpoint of efficient operation, this is due either to inadequate weather forecasting - a presumably correctable fault -; or to imperfections, faults, in the pilot's flying capacity including his understanding of weather forecast; or to faults in the engineering on the structure of the plane.

14. Interaction between men and the machine and the conditions under which the machine is used stands out with especial clearness in another fertile source of "accidents", especially in a training Air Force. This particular instance shows with special force why it is essentially futile to assess the "causes" of unwanted happenings in terms of percentage responsibility, pilot so much,.... Reference is made to the fact that, as studies in the United States and also in England have abundantly shown, the first ten hours or so of use of a plane new to pilots (usually, during progressive training) the "accident rate" is tremendously increased. It is pretty clear that the novelty of the instrument panel, the controls, and in general of the cockpit organization, must be a factor in this upsurge of unwanted, damaging, incidents. The basic fault here lies in a lagging comprehension of the understanding of the significance of the interrelations between man and machine in the operation of a military airplane. It is silly to find charged to "Pilot error" a mishap, however serious, which is probably just one instance of the impersonal, general fact that, under stress, human beings revert to acts for which they are already conditioned. Elementary common sense suggests that strenuous effort should be given to the standardization of basic flight instrument installations. The fault here lay in the failure to realize this quickly, and to act promptly upon the realization. It is understood that something like two years were absorbed in the decision upon a standardized instrument panel for single-engined army aircraft. In the recently published accounts of this accomplishment, no reference is made to its significance for the reduction of "accidents", nor to the more intricate problem of cockpit organization in multi-engined aircraft.





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15. Examples could easily be multiplied; for example, in the design and installation of Radar equipment; but the intention here is merely to ask for a reconsideration of the terminology of the reporting and the analysis of unwanted, unforseen, damaging, inefficient occurrences in the use of military aircraft (excluding for the moment results of enemy action, although this is in fact a part of the same problem). The same type of unclear thinking, with reference to the real objective, as is shown in the operational definition of "accident" in this connection is also exhibited in the use characteristically made of "accident rates". These figures, in terms of frequency of "accidents" per 1,000 hours of flying, can be viciously misleading. I say viciously misleading, because they directly tend to obstruct the purpose supposedly in view, namely the increase of efficiency in the use of military aircraft in time of war. Of course it is true that any gross reduction in "accident rate" is desirable; but the point is that with an objective realization of the immediately relevant factors it is unquestionable that a faster reduction of unwanted incidents, consequences of faults, could be obtained. The vicious quality of the customary "accident rates" lies essentially in their giving a spurious numerical specificity to an incompletely apprehended situation. They have definite imperfections for analytical purposes. They may be useful when comparisons are made between two groups of the same type under similar conditions of service. They can be very misleading when the performances of planes of different kinds are to be contrasted under necessarily different circumstances. In another direction, a current (and valuable) publication from Third Air Force is instructive. As has been done before (by OFS), comparisons are instituted between Air Forces in the United States as to their "accident rates". The simple fact that the proportions of different aircraft and the administration of their use is vastly different in the several domestic Air Forces completely destroys the possibility of real usefulness in any such comparisons. The "tyranny of words" is no idle phrase. Once a word with complex significance is introduced in a special meaning, as has happened with "accident", nosensical, inefficient consequences are inevitable. Words do condition thinking.

16. The real intent of this note is to incite if possible an active state of thought about the significance of faults in aircraft design and operation. The precise terminology used in denoting the recognition and classification of these faults may seem an academic matter, but in fact it is not. Terms, words, do condition action. The efficient use of aircraft, with their multiple hazards, in military operations against the enemy, encounters fantastic obstacles arising from the special interests and peculiar limitations of persons and combinations of individuals directly involved on the precombat front. This is an essentially human situation. All concerned can benefit, and the war effort can be sharpened, if an objective consideration of faults of conception, management, execution can be recognized so that they may be corrected. This benefit is rendered much more difficult by an obscurantist terminology with respect to the mere naming of undesired occurrences in the use of military aircraft.

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Hence it is suggested that the term accident be suppressed, and that in its room there be used a term without the unfortunate and essentially irrelevant connotations clustering about the word "accident", some other less biased term. "Fault" has been suggested. If discussion can improve on this, or devise a totally new label, it will be welcomed by all who search for an objective, dynamically significant aid toward the realistic handling of a serious problem.

W. J. CROZIER
Operations Analyst
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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9 October 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS SECTION, SECOND AIR FORCE

Subject: Report on Trip to Grand Island, Nebraska

1. 7 October 1944. Left Hq. Second Air Force, staff car, 9:35 AM, for Peterson Field, thence by B-17 (Maj. Stallings) to Grand Island to investigate B-29 crash landing and attending circumstances, with committee (Maj. Stengle), Arrived Grand Island 1:30 PM (CWT). Well received; Lt. Col. Mackey, Adj., in charge in absence Base Commander. Plane on runway, well guarded. We were well received and throughout every thoughtful co-operation was provided.

2. A remarkable accident. It should be competently and completely written up. I am able here to give only a general summary of my impressions. The occurrence should be written up for two reasons:

a. The accident comprises some seven type accidents, all in serial combination.

b. The event showed that it is possible for a crew which has worked together, with a competent Commander, to behave in a coordinated manner. Disposal of personnel for crash, preparations for internal fire, and final exit of crew were carried through smoothly.

3. From the standpoint of the B-29 power plant installation, 3 points emerge:

a. This is a "marginal" power plant; it is illustrated again that if one engine fails, there is a high probability that another engine will also fail.

b. It is worse than useless to pull $CO_2$ extinguishers when magnesium alloy has been heated by fire of any origin in the nacelle; in the present case of No. 2 engine, pending examination at take down (one could not yet inspect the remains of the impeller duct), I presume that the fire started (oil?) outside the impeller;*

c. Oxygen cylinders should be removed from low positions in bombay to places well above the bomb-bay door hinge line.

4. The "type accidents" exhibited were:

a. Poor inspection (100 hour inspection 7 hours previously,

(*this was incorrect; fire due to faulty exhaust -valve clearance, as discovered on take-down.)

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failing to detect an obviously old system of cracks in carburetor base); pretty clearly the result of a backfire; no record of backfires obtainable.

b. Failure of an outboard engine at take-off.

c. Failure of landing gear (1) to extend completely.

d. Failure of nose gear to extend.

e. Loss of power on one engine (probably No. 2), coupled with possible loss of power on another (here, No. 1), and probably resulting in a mistaken feathering of an engine (No. 1).

f. Impeller region fire in another engine (No. 2).

g. Added danger of using $CO_2$ "extinguisher" under circumstances in f.

h. Oxygen fed fire can be avoided on belly landings if $O_2$ bottles are mounted well above line of bomb bay door hinge.

i. A skillful landing on concrete even with all wheels up can be less injurious than a comparable one on dirt.

j. An outstanding fact is the fear which crew members, notably engineers, who know the situation, have concerning engine fire in the air.

W. J. CROZIER,
Operations Analyst.

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Copies of Individual Records, B-29 Crew, Grand Island, 7 October 1944.

The men (Pilot, Co-pilot, Engineer, chiefly) were interviewed; they were then set to writing out testimony, under supervision. They were then examined individually on their typed records. Additional points developed were then noted (Mr. Gillie has a detailed record of remembered times, altitudes, power settings, r.p.m., as checked back and forth.). A fair copy was then prepared and signed; the preliminary copies had also been signed. The final original copies are in Maj. Stangle's possession.

W. J. CROZIER,
Operations Analyst.

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7 November 1944.

NOTE TO: Dr. J. Kaplan.

SUBJECT: Accident Report.

I note that there have been omitted from the Final Report of the Accident Investigation Committee on B-29A Airplane No. 42-93843 (18 October) certain points made in my preliminary condensed summary:

(1) No specific mention of $CO_2$ used in attempt to extinguish engine fire in impeller region.

(2) Recommendation to re-position $O_2$ now at low level in bomb-bay.

(3) No comment is made on the mental attitude of crew members, notably engineers, concerning the liklihood of fires in the air. Dr. La Paz has also had an excellent opportunity to note this important fact.

W. J. CROZIER
Operations Analyst
Twentieth Air Force

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HEADQUARTERS SECOND AIR FORCE
Aircraft Maintenance Branch
Engineering Section

18 October 1944

SUBJECT: Report Covering Accident Concerning B-29A Airplane, Serial No. 42-93843.

TO: Lt. Colonel David M. Van Ornum, Chief of Engineering Section, Aircraft Maintenance Branch.

1. Pursuant to authority contained in paragraph 25, Special Order No. 280, Headquarters Second Air Force, dated 9 October 1944, an investigation was conducted on B-29 airplane crash at grand Island, Nebraska, 7 October 1944.

a. The Investigation Committee consisted of the following:

MAJOR PAUL I. STANGLE, 0418660, AC, Sec D (Staff), 200th AAF Base Unit, (Hq BU). Colorado Springs, Colorado.

MR. AUBERT E. BENNETT, Civ Emp. Wash, DC, TD Hq 2AF.

DR. WILLIAM CROZIER, Civ Emp. Hq AAF, Wash, DC. TD Hq 2AF.

MR. JAMES M. GILLIE, Boeing Representative, Hq 2AF.

MR. MAURICE R. HULL, Wright Aeronautical Corporation Representative. Hq 2AF.

2. Airplane and Power Plant.

a. Airplane.

(1) Type B-29A, 42-93843.

(2) Total airplane time, 149:45 hours.

(3) Engine Position #1, Type R-3350-23A, 43-149622, 107:10 hours total time.

(4) Engine Position #2, Type R-3350-23A, 43-149649, 107:10 hours total time.

(5) Engine Position #3, Type R-3350-23A, 43-149775, 107:10 hours total time.

(6) Engine Position #4, Type R-3350-23A, 43-14939, 107:10 hours total time.

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Subj: Accident to B-29A Ap No. 42-93843.

b. Airplane was on red diagonal for the following:

(1) Compass swing was due.

(2) Number three (#3) fuel pressure low.

(3) Radio Compass defective.

3. Personnel Involved.

a. The following listed personnel constituted the crew of the airplane for the flight in question:

(1) Commander, Jeffrey Richards, Captain, O-727547.
Total time on B-29, 36:35 hours.

(2) Pilot, L. M. Jepperson, 2d Lt., O-770675,
Total time on B-29. 37:00 hours

(3) Navigator, I. L. Podell, Flight Officer, T-126787.
Total time on B-29, 22:00 hours.

(4) Bombardier, Lawrence L. Lewis, Flight Officer, T-127845,
Total time on B-29, 28:35 hours.

(5) Flight Engineer, Martin Seletsky, Staff Sergeant, 13006982.
Total time on B-29. 25:25 hours.

(6) Left Blister Gunner. Normand H. Lemoi, Corporal, 31387281.
Total time on B-29, 27:55 hours.

(7) Right Blister Gunner, Charles Pitts, Corporal, 35773802.
Total time on B-29. 27:55 hours.

(8) Tail Gunner, Willian A. Johnston Jr., Corporal, 13188268,
Total time on B-29, 27:55 hours.

(9) Top Gunner, Stanley L. Powell, Corporal, 36829689
Total time on B-29, 27:55 hours.

(10) Radio Operator, Robert Manley, Corporal, 39704433.
Total time on B-29, 25:20 hours.

(11) Radar Operator, Edward D. Fischer, Corporal, 33697055.
Total time on B-29, 29:20 hours.

4. Summary of Events Leading to Accident. (Ref. Incl. #1)

a. Engines were run up at 0725 at end of runway #3. Takeoff roll was started at 0735, using normal power, 2600 RPM and 47.5" M.P. As





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airplane became airborne at about 110 MPH indicated air speed, #4 engine began smoking behind cowl flap, flames were noted coming from turbo, and engine was feathered. Fire immediately went out without use of fire extinguisher. Gear was immediately retracted, flaps were milked up at 145 to 160 MPH and climb made at approximately 180 indicated air speed, using normal takeoff power on the three remaining engines to approximately 1000 feet above the field without leaving the pattern.

b. On the base leg, it was decided to return to the field and an attempt was made to lower the gear. Right and left gear went down and were reported by scanners as being down but right gear indicator light did not go on. Both normal and emergency procedure failed to extend the nose gear. When it became evident that nose gear would not extend, main gear was retracted and climb continued to 6000 feet. Power setting was 43" M.P. and 2400 RPM. At no time did any cylinder head temperature exceed 230°. Indicated air speed in this climb was 180 MPH; rate of climb was approximately 200 feet per minute.

c. The airplane was leveled off intermittently during the climb to gain air speed. After leveling off, using both normal and emergency systems as outlined in Second Air Force Standard Operating Procedures, several attempts were made to lower gear again. During these attempts, the left gear was observed to extend completely and indicator light came on. The indicator light did not come on for right gear and blister gunner reported gear only partially extended. Nose wheel also failed to extend although both emergency and normal motors were observed to be operating under load with indications that clutches were slipping.

d. At this time, the gear was retracted. During the attempt to lower gear, the airplane lost altitude to 4800 feet. At this altitude the tower gave instructions to stand by awaiting suggestions from a Boeing representative. Immediately after this, the manifold pressure was observed to be dropping on #2 engine so it was feathered. Within thirty (30) seconds, the manifold pressure was also observed to be dropping on #1 engine and it was likewise feathered. Airplane appeared to be losing altitude so rapidly that a successful attempt was made to bring in #1 engine. This engine ran normally but only 35" M.P. could be obtained. Because of the success with #1 engine, an attempt was made to bring in #2 again. No. 2 engine came to approximately 30" M.P. when flames were observed to be coming from nacelle. The fire extinguisher was pulled on #2 engine but was ineffective. An attempt was again made to feather #2 but was not completely successful as it still windmilled at approximately 200 RPM. During this time, the landing pattern was being completed and within three (3) minutes after the fire broke out, the airplane was crash landed, using 25° flaps. The landing was made on runway #3 at 0835. The crew evacuated the airplane without injury. A Cardox truck arrived at the crash within thirty (30) seconds and successfully extinguished the fire in #2 engine.

e. The pilot's ex lanation of deviating from normal wing flap



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setting was that he wished to make a shallow approach.

f. Fire broke out beneath the center wing section due to the sliding contact with runway. This fire was oxygen fed but was successfully extinguished by the fire crew. Immediately after fire was extinguished, guards were posted and airplane was held for investigation by Second Air Force Accident Investigation Committee.

5. Investigation and Inspection of Airplane.

a. The Second Air Force Accident Investigation Committee arrived on the scene at approximately 1300. The group inspected subject airplane and photographs were made of all pertinent items. (See Incl. #2)

b. The airplane was placed on jacks and a thorough inspection was made regarding the possibility of additional fire. Guards were posted at all critical points. External power was connected to the airplane and the nose wheel was disconnected electrically from both normal and emergency systems and the main gear was fully extended, using normal procedures. Both main gear green lights came on, indicating gear was completely down and locked. The jacking configuration was the reason for not attempting an extension of the nose gear at this time.

c. After main gear was completely lowered, check and down locks installed, the front end of the airplane was jacked and cribbed. Approximately an additional six (6) inches was allowed for extension of the nose gear. Normal and emergency electrical systems were then reconnected to the nose gear. An attempt was made to extend subject gear, using the normal system. This failed. An attempt was made to extend the nose gear using the emergency system and this also failed. During both of these procedures, nose wheel retracting motors were observed to be operating normally with the clutches slipping. External loads were also applied to the gear in an attempt to break it free.

d. Inasmuch as neither normal or emergency systems were observed to accomplish the extension of the gear, an attempt was made to extend the gear, using both systems concurrently. Gear failed to extend using this procedure. Since all recommended procedures had now been tried without result, a short consultation was held in an attempt to determine the reason the nose gear failed to extend. It was suggested that perhaps the emergency landing gear switch had been wired backwards. The emergency switch was then placed in the "up" position and the gear was observed to retract slightly. The switch was then thrown to the "down" position and the gear extended completely.

6. Power Plants.

a. Inspection revealed the following:



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Subj: Accident to B-29A Ap No. 42-93843.

(1) No. 4 engine.

(a) Exhaust valves with the rocker box covers removed did not have excessive clearances and showed proper adjustment with no external evidence of failure.

(b) The magnetic sump plug was found to contain a large amount of metal particles.

(c) The breather was found to be disconnected at the engine.

(d) Critical plugs were pulled and #14 and #16 were found to be very oily, indicating possible piston failures.

(e) Carburetor screens were observed to be clean and properly installed.

(f) In removing the carburetor, the mounting flange on the right, left, and rear sides were found to be cracked about one (1) inch to three-fourths (3/4) inch from the base of the carburetor.

(g) It was noticed that there were small metal flakes distributed over the entire left hand external side of the engine.

(h) The entire rear left hand side of the engine was covered with oil.

(i) The turbo amplifier was found to be defective when operation of waste gate was checked. This resulted in a wide open waste gate.

(j) Later removal of the #16 cylinder showed its piston and articulating rod to be broken. The #14 articulating rod was also broken.

(2) No. 3 Engine.

(a) No defects were apparent on this engine.

(3) No. 2 Engine.

(a) Fire burned the front and rear superhousings, impeller, carburetor, accessories and upper rear half of nacelle, including all structural members.

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(b) External inspection of the exhaust valves on critical cylinders revealed #14 exhaust valve to have an excessive clearance of approximately .225 inches. Further inspection through the exhaust port disclosed the exhaust valve seat to be missing and the valve head to be cracked. This cylinder had been changed six hours previously.

(c) The magnetic sump plug was removed and did not contain any metal particles.

(d) The rear of the carburetor had not burned away so the carburetor screen was inspected and found to be clean.

(e) The turbo waste gate operation was checked and found to be satisfactory.

(4) No. 1 Engine.

(a) This engine was completely inspected, including screens, turbo, and exhaust valves of critical cylinders. All were in working order.

(b) The propeller was removed and a run-out on the prop shaft was found to be within limits. A serviceable propeller was installed.

(c) The engine was started normally, warmed and a power check made. Without turbo boost, approximately 36" at 2400 RPM was obtained; with the turbo dial at #8 position, full takeoff power was developed.

7. Nose Gear.

a. Inspection of the nose gear revealed that during a previous disassembly and assembly in order to install bumper shims, the two screws locking the retracting nut to the retracting tube had not been replaced, allowing the nut to rotate and screw itself forward and partially out of the tube assembly. This phenomenon occurs only on extension, retraction driving the nut tighter into the tube against an internal stop and doing no particular harm. As the pitch of the screw threads anchoring the nut to the tube is less than that of the main power translating screw, a differential motion between the nut and tube surfaces with no accompanying differential motion between the nut and power translating screw, will extend the gear to a much less degree than that normally experienced. When this is so, the opposing stops fail to release and lock the gear after approximately 310 degrees of rotation in a direction intended to extend the gear. This particular sequence of events was found to have prevented the gear from extending in the air. It is of interest to note that the successful extension accomplished on the ground was



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due to the gear being further retracted initially. This procedure drove the retracting nut with sufficient force against the internal stop to prevent any relative motion between the nut and tube, allowing normal extension to be accomplished.

8. Airplane Structure.

a. Inspection revealed the following:

(1) Pressure bulkheads at front of front bomb bay and rear of rear bomb bay, bomb doors, body skin from forward turret-well to aft pressure bulkhead, stringers, and circumferentials in this area, were badly damaged. In addition, fire had badly burned bottom of center wing section, indicating replacement of this assembly. Radar dome and forward turret were completely destroyed.

9. Conclusions:

a. It is believed that fire in #4 engine during takeoff was caused by the following sequence of events:

(1) The crack in carburetor mounting flange was believed to have been a progressive failure. This may have been the result of an excessive backfire at some previous date. This crack could have resulted in a lean mixture causing detonation and engine failure. The failure was probably a damaged piston which allowed oil to escape into the exhaust collector; also excessive pressure in the power section which resulted in the blowing of metal flakes and oil out of the disconnected breather. The excessive oil in the exhaust collector along with high collector ring temperature caused the fire in the turbo exhaust. The smoke coming from the cowl flaps was caused by oil coming from the disconnected breather and burning on the exhaust collector.

(2) Failure of #4 engine indicated an immediate return to the field with the accompanying preliminary landing procedures. It is believed the crew made a complete check of all normal and emergency operational techniques while attempting to lower the gear. There is conclusive evidence that the nose gear failed to extend. It is further evident that this was not an electrical failure but was due to improper assembly after a recent removal of the gear. It is also believed that if the nose gear had extended, the airplane would probably have made a successful landing on its first attempt.

(3) The drop in manifold pressure which resulted in the



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first feathering of #2 engine might have caused the fire, resulting from the excessive clearance in the #14 exhaust valve adjustment. This maladjustment later led to the valve failing to open when the engine was very warm and allowed the cylinder to exhaust into the induction system. This probably caused the induction fire and lowering of manifold pressure. It is also possible that in attempting to feather this engine, #1 engine was inadvertently feathered, which resulted in the decrease in manifold pressure on #1 engine. This is substantiated by the fact that #1 engine was later unfeathered in flight and did develop 35", and further by the fact that ground operation of this engine revealed it to develop full power both with and without turbo. It is believed that the first power loss in #2 engine was caused by a fire in the impeller section which was extinguished when the propeller was first feathered and subsequent fire was developed when the engine was started for the second time.

10. Recommendations:

a. It is recommended that:

(1) Second Air Force flight crews be cautioned against feathering an engine too soon.

(2) A study be made of existing emergency landing procedures to determine the possibility of including additional procedures to be used with a stuck gear. This procedure being to attempt to operate the gear in both directions on the emergency system in order to break free any mechanical lock which may occur therein.

(3) Inspection and maintenance be advised to look for possible breaks on carburetor mounting flanges. Also that crews be required to report any severe backfiring to the Maintenance Officer so that inspection can be made for possible damage to the induction system. This inspection is imparative to insure complete safety to all flying personnel.

(4) Although the committee completely concurs in the airmanship shown in bringing this particular airplane to the ground, the damage resulting in landing the airplane again proves the advisability in landing the airplane with S.O.P., namely, all gears extended which will extend.

(5) The program of equipping B-29 engines with short cowl

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flaps, operational top cowl flaps, cross-over tubes and ducted baffles be expedited to training airplanes. The superior cooling characteristics of this equipment might have assisted in maintaining without failure, the higher powers required in emergencies of this nature.

(6) An Accident Investigation Committee composed of Second Air Force maintenance personnel be expedited to all B-29 accidents.

(7) Closer and more rigid inspection be given the crews when valve adjustments are made. It should be emphasized that no one should make valve adjustments who has not been personally checked by a crew chief.

(8) Closer and more rigid inspection be given the crews when overhauling or adjusting landing gears.

(9) The airplane commander and entire crew be commended for the excellent airmanship and coordination displayed in bringing this airplane to a successful landing.

MAJOR PAUL L. STANGLE

MR. AUBERT E. BENNETT

DR. WILLIAM CROZIER

MR. JAMES M. GILLIE

MR. MAURICE R. HULL

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CONFIDENTIAL

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SUBJECT: B-29 Accidents

TO : A-4, Twentieth Air Force 11 April 1945

FROM : Chief of Staff, Twentieth Air Force FLM/jc/74730

1. For the month of March in the Continental U.S., 7 of 11 accidents with power plant failures involved engine fires. This represents one-third of all accidents for the month, and is the largest number of engine fire accidents for any single month in the history of the B-29 aircraft. The accidents killed 18 crewmembers, caused major injuries to 7 and minor injuries to 20 others. In addition, four aircraft were wrecked and 3 received major damage.

2. Already for the first 11 days of April, 6 accidents have occurred in the Continental limits. Of these 6 accidents, 4 involved engine fires. These 4 engine fires have contributed to the death of 12 crew members, 3 suffered major injury and 2 minor injury. 2 aircraft were completely destroyed and 2 suffered major damage.

3. The seriousness of the B-29 engine fire problem has been recognized for a considerable length of time. In an attempt to rectify this hazardous and costly situation, a B-29 engine fire conference was held at Wright Field on 5 February 1945. It was the recommendation of the conferees that as an interim measure, the following installation be accomplished immediately in production or modification, and supplied in kit form for installation in the field:

a. A small fire indicator which will light a warning light on the engineer's panel indicating fire in the induction system, and a $CO_2$ line from the present $CO_2$ fire extinguishing system to the engine induction system for the purpose of extinguishing an induction system fire by merely discharging a $CO_2$ bottle by use of existing controls on the flight engineer's panel.

4. In view of the fact that over two months have expired since the Wright Field conference, and in the light of the continuing serious consequences of B-29 continental engine fires, it is believed that the most expeditious action possible should be exerted to procure and install the interim fire fix in the B-29 as decided upon at Wright Field.

5. This Headquarters desired to be informed of the present status of the fire extinguisher system and fire indicator and the schedule of installation in all B-29 aircraft.

LAURIS NORSTAD
Brigadier General, U.S.A.
Chief of Staff, Twentieth Air Force

COORDINATION:

Flying Safety
Operations Analysis
Section

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R & R Comment 1, dtd 11 Apr 45 to A-4, Twentieth Air Force, fr Chief of Staff, Twentieth Air Force

SUBJECT: B-29 Accidents

TO : Chief of Staff, Twentieth Air Force 16 April 1945
Comment No. 2

FROM : Asst A-4, Twentieth Air Force, M & S Lt Col Shank/bta/3563

1. The improved fire extinguisher system, as outlined, in Comment No. 1, will be incorporated in modification centers on all B-29 aircraft on and after 20 May 1945, except for the installation of the fire indicator. Lack of availability of the fire indicators prohibits installation of 20 May, but present information indicates that the installation of the fire indicator will be accomplished on and after 15 Jun 1945. Previous to this time, however, all aircraft having the improved fire extinguisher system incorporated will be equipped with all provisions for the fire indicator, whereby it can be easily installed when available.

2. Efforts are being exerted to obtain sufficient parts for retroactive installation supply to service activities concurrently with incorporation of the modification change in aircraft.

3. The change to the improved fire extinguisher system has been under very high priority since the conference on 5 February 1945. The production change in which a greater supply of $CO_2$ will be made available for extinguishing both induction system and nacelle fires, is under the highest priority possible and is #9 on the Boeing Engineering Priority List. It is preceded only by such changes as the separate propeller oil feathering tank, modified fuel system, landing gear position indicator, etc.

4. The B-29 engine fire problem has been recognized by all engineering activities as one of major importance. At the meeting held on 5 Feb 1945, referred to in Comment #1, discussion brought out that the majority of fires have occurred with domestic activities, primarily in training, thus indicating that much of the difficulty exists in unskilled maintenance and improper operating technique. Recommendation has previously been made by this office that appropriate action be taken to impress upon organizations having a bad fire record in B-29 airplanes, the importance of adequate maintenance and proper operating technique. It is believed that with the proper equipment, improved maintenance and [illegible], a major decline in nacelle fires will result.

JOHN G. MOORE
Colonel, Air Corps
Executive, AC/AS, M&S

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SUBJECT: Ditching Reports

TO : Chief of Staff, Twentieth Air Force

FROM : AC/AS,OCMR, A-3, Twentieth Air Force

4 July 45
Comment No. 4
Capt. Carveth/gbl/74687

1. Reference is made to the attached comments of Dr. Stearns, Operations Analyst of the Headquarters, covering the ditching reports of the XXI Bomber Command.

2. The comments listed under paragraph 1 are answered by Comment No. 3 above.

3. Action has now been completed to standardize the B-29 ditching procedure used by the XXI Bomber Command. The Office of Flying Safety and the Air Technical Service Command have been requested to revise all pertinent publications covering B-29 ditching procedures to conform with the XXI Bomber Command's procedure. However, the XXI Bomber Command's ditching record does not indicate that their procedure has been completely standardized within the Command. The procedure set forth in the XXI Bomber Command Air-Sea Rescue Manual has only been used in twelve (12) cases out of twenty-five (25) of the latest ditching incidents.

4. It is understood that an officer, recently returned from the European theater of Operations has been assigned to the Air Technical Service Command to work directly under the Coordinator of Personal Equipment. It is further understood his principal duty will be to insure that the latest emergency and personal equipment is made available to the theaters of operations with the least practicable delay. It is believed that this move will aid in solving the equipment problems listed in paragraph 2 of the attached comments.

3 Incls: n/c

Emer Res Branch_____

Requirements Div._____

GEORGE W. MILL, JR.
Lt. Colonel, Air Corps
Executive, Ass't Chief of Air Staff
Operations, Commitments & Requirements

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SUBJECT: Ditching Reports.

TO : AGAS/OCAR, Requirements Division

FROM : AGAS/MRS, Material Division

28 June 45

Comment No. 3

Major F C Oakley/jem
3831

1. Information requested in Paragraph 2, Comment 2, is given below in the same order as in Comment 2.

a. Paragraph 1a: Handles of rafts have recently been strengthened to the point deemed safe for raft operation. Attachment of handles to rafts cannot equal or exceed the strength of the raft without danger of pulling out the side of the raft instead of simply pulling off the handles. Air Technical Service Command will be instructed to make a further check on this matter and to see that information is provided the theaters regarding proper use of the handles and their necessary limitations.

b. Paragraph 1b: The attached copy of 1st Indorsement to Air Technical Service Command dated 24 May 1945, subject: "Rope for Multi-Place Life Rafts", indicates the action that has been directed. There had hardly been time for this action to be felt in the theater, but Air Technical Service Command is being queried as to progress.

c. Paragraph 1d: The problem of removal of the astrodome in preparation for ditching is recognized by Air Technical Service Command and Boeing, and improvements are in the design state. The installation has been satisfactory in the continental United States, but probably due to the weather conditions in the overseas theaters, the sealing compound has deteriorated in many cases, and normal removal has been impossible. This difficulty was not recognized until fairly recently. Until such time as the improvement can be found and incorporated, the removal must be accomplished by means of a sidearm, if normal removal cannot be accomplished.

d. Paragraph 1e: Reinforcement of the bulkhead beams is not the answer to the present difficulty, inasmuch as the failures of the beams can be attributed to a great extent to failure of the door. This problem is recognized, and Boeing is designing a new door which will have greater resistance to the sudden water pressures occasioned by ditching. B.A.C. change number 776 has been assigned to this project.

e. Paragraph 1f: The attached copies of letter, dated 17 April 1945, from Air Technical Service Command, and 1st Indorsement, dated 10 May 1945, subject: "Quick Release Assembly Parachute Harness", indicates the action that has been directed. There has hardly been time for this action to be felt in the theater, but Air Technical Service Command is being queried as to progress.

3 Incls:
1. n/c
2. Cy 1st Ind dtd 24 May 45 to ATSC
3. Cy ltr dtd 17 Apr 45 frm ATSC 2/1 Ind

FRED. R. DENT, JR.
Colonel, Air Corps
Chief, Engineering Branch

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SUBJECT: Ditching Reports

15 June 1945

TO : AC/AS,OC&R. Attn: Emergency Rescue Branch

Comment No. 1

FROM : Chief of Staff, Twentieth Air Force

FLMcI: 1h74730

Your attention is invited to the comments of Dr. Stearns, Operations Analyst of this Headquarters, covering the ditching reports of the XXI Bomber Command. Please return memorandum and reports to this Headquarters.

1 Incl
Memo 14 June
3/6 rpts.

FRED L. MCINTYRE
Major, AC
Ofc Deputy Chief of Staff

TO: Asst C/AS, M&S, Materiel Division

26 June 1945

FROM: Asst C/AS, OC&R (Requirements Division)

Comment No. 2

Capt Carveth/cpw/74687

1. Reference is made to Paragraph 1 of attached Memorandum for Dr. Robert L. Sterns, subject: "Comment on Certain Ditching Reports," dated 14 June 1945.

2. Request information as to the status of the following points listed in the report:

a. Paragraph 1a: It is understood that the ATSC is presently conducting tests to determine a suitable handle for life rafts which will not tear off.

b. Paragraph 1b: The inclusion in life raft stores of two (2) 30 ft. lengths of rope treated with anti-fungicide compound has been standardized. Theaters of operations were given first priority to meet the additional rope requirement.

c. Paragraph 1d: Self-explanatory.

d. Paragraph 1e: Reference is made to R&R, subject: "Emergency Rescue Modification", dated 19 May 1945. It is understood that a project has been established to determine the feasibility of such an installation.

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SUBJECT: Ditching Reports

TO: Asst C/AS, M&S, Materiel Division

From: Asst C/AS, OC'AC (Requirements Division)

26 June 1945

Comment No. 2 cont'd

Capt Carveth/cpw/74687

e. Paragraph 1f: It is believed that this difficulty has been corrected in quick release boxes for Types A-5, B-10 and later model A-4, B-9, and S-4 parachutes. The difficulty was apparently encountered in release boxes manufactured by certain companies. Please return memorandum and reports to this Office.

Incl: n/c.

Emer. Res. Br._____

Asst. For M&R_____

LESLIE C. PETERSON
Colonel, Air Corps
Acting Chief

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HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D. C.

14 June 45

NOTE FOR DR. ROBERT L. STEARNS, CHIEF.

SUBJECT: Comment On Certain Ditching Reports.

1. Reports of certain comparatively recent B-29 ditchings (314th Bombardment Wing) contain some points which seem to merit notice.

a. It appears that handles on life rafts continue insufficiently strong--they tend to tear off.

b. The absence of adequate rope in the dinghys continues to be criticized.

c. There is one instance recorded of APU breaking lose, with injury to crew members properly positioned for ditching. This seems to be the first instances of such occurrence. The possibility that an attempt had been made to loosen its fastenings for jettisoning seems to be negatived by the statement that "Recommend that putt-putt be anchored more firmly or that ditching position of personnel in that section be changed (314th Wing Air Sea Rescue Report No. 6, 29 May 45).

d. It was recommended in several instances that stronger bracing be provided for the bulkhead pressure door. As a practical matter, this apparently resolves itself into a balancing of the virtues of (1) accessory "braces", (2) strong "dogs" about the circumference of the door. Item (1) would seem to have comparitively little to recommend it.

f. The socalled "quick release" parachute harness seems to require heroic action for effective use.

2. There seems still to be a kind of uncertainty about "standard" B-29 ditching procedure. The suspicion is warranted that relevant drill procedures have not been enforced with anything like adequacy. A certain number of questions recur with distressing regularity, and with shocking lack of resolution. Experience has been comparatively large in terms of ditched aircraft. We know nothing about the experience of the fairly large number from which no possible survivors have been rescued. There has been no very real sign of effective improvement, since Jan. 45, in the

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distribution and use of physical apparatus for survival. Metal oars at Dayton, struggles over Nylon rope (resistant to sea water), a dozen other items---the elementary problems of raft stowage and release --stowage of "survival kits".... The question is insistant, why have not these problems been solved? They have been recognized for at least six months--in fact, as far back as Nov '43 (Most of these problems were apparent by at least August, 1944, as I can personnaly testify).

WJC:evd

WILLIAM J. CROZIER
Operations Analyst

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By Authority of
The Commanding General
Army Air Forces
5 Jan 45 R.L.S
Date Initials

TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

OPERATION ANALYSIS REPORT

SUBJECT: The Nature and the Control of B-29 Engine Fires, with Special Reference to the Problems of Magnesium

DATE: 5 January 1945

AUTHOR: Dr. W. J. Crozier

IDENTIFICATION: Report No.

Note: Operations Analysis Sections (designated in some theaters as Operational Research Sections) have been established in a number of Air Force Commands pursuant to a memorandum from CG AAF to All Air Force Commanders, dated 24 October 1942, approving this activity.

This is a report of one such Section. Information as to Operations Analysis Sections and reports can be obtained from Operations Analysis Division, Management Control, Headquarters, Army Air Forces, Washington, D. C.

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C. Magnesium Fires

1. Magnesium as a Fire Risk
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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

5 Jan 1945

The Nature and the Control of B-29 Engine Fires, with Special Reference to the Problem of Magnesium.

A. Summary and Recommendations:

1. Power plant failures, with the presence or the definite risk of engine fire, account for something like half of the unwanted, disastrous occurrences involving loss or serious damage to B-29 aircraft. Power plant troubles of one or another degree are the most obvious single "cause" of failure to bomb the primary designated target. Engine fires are definitely involved in 25 to 30 percent of the officially recorded "accidents", domestically and overseas. There is as yet no substantial indication that current structural modifications relative to the engines have significantly affected this proportion in B-29's.

2. The high proportions (at least one third) of instances involving "accidents" in which the loss of one engine has been followed by the loss of another, emphasises the marginal significance of the B-29 power plant in terms of demands made upon it. This is not to be taken as an adverse criticism of the abstract quality of the R-3350-23 engine. It implies merely a factual description of the inadequacy of the power plant installation of the B-29 aircraft.

3. The prominence of engine fires in the history of the B-29 has produced a definite and unusual reaction on the part of the operating crews: they are "on edge" in the domestic region at least, and (one has some reason to believe) overseas, regarding the reliability of the power plant and the significance of engine fires.

4. The role of engine fires in this situation is highly exaggerated by the presence of magnesium alloy components in the engine assembly. Magnesium fires (arising from oil fires, or directly from impeller region combustion as a consequence of "back fires" or valve swallowing) are peculiarly difficult to extinguish. Carbon dioxide as provided is not an extinguishant for the magnesium fires in engine nacelles - it feeds them.

5. It is possible that by the aid of already-tested flame warning devices, $CO_2$ could be delivered to the impeller duct in back fires, in time to prevent ignition of the magnesium. Definite limitations are to be expected as regards the successful operation of this type of fire control. however.

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6. It is possible that by the use of anhydrous liquid ammonia (which can also extinguish oil fires and gasoline fires), magnesium fires can likewise be extinguished in engine nacelles. (This seems not to have as yet been adequately tested in engines). No other usable extinguishant for magnesium fires has been found, after rigorous search.

7. The percentage significance of magnesium fires in the total picture of unnecessary B-29 losses cannot be precisely estimated; but it is a serious factor. The direct way to eliminate it is to remove magnesium alloys from the aircraft engines. The weight penalty has been estimated at well under 100 lbs. if aluminum alloys should be substituted; even if the weight penalty should be greater, the substitution would be worth most serious study.

8. The only real solution of this eminently prominent defect of the B-29 aircraft is to provide a power-plant with a larger factor of safety as regards power demands and their consequences. The utmost possible expertness of operation cannot in reason be expected of the majority of operating crews. A larger safety factor should be provided. There are good reasons for suspecting that a fuel-injection model of the present engine may not be adequate. Yet it is clear that if the B-29 program is to achieve full significance the obvious problem for corrective attack is the improvement of the power plant. The reduction of the incidence of unmanageable fires by excluding magnesium from the engine nacelles is perhaps, in terms of the production set up, the simplest step. The reduction of unmanageable engine fires would do more than any other single thing to increase the military effectiveness of B-29 aircraft.

B. Engine Fires:

1. Engine Failures and Engine Fires.

Engine failures, involving actual and potential engine fires, have been frequent with the B-29 power plant. The fires accounted, from February 1943 up to October 1, 1944, for roughly 28 per cent of B-29 "accidents" at take-off and in the air, -- including both domestic and overseas areas of operation (so far as information from combat theater is available).

a. An examination of data on all accidents reported in the operation of the first 500 B-29 airplanes has been possible through the active cooperation at Seattle, and at Colorado Springs, of Mr. Amos L. Wood, Field Service Engineer, Boeing Aircraft Company. This study was made to compare the sources of accidents during the development and early use of the B-29 with those appearing during the corresponding period (500 planes in use) in the history of the B-17.

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The results supplement the analyses of data on B-29 accidents within Second Air Force, since they comprise a somewhat greater number of instances, and are based upon an independent and somewhat different point of view.

b. Mr. Wood's table shows that (as of 9 August 1944) failures of power plant accounted for 28 per cent of all B-29 accidents, as contrasted with 4 per cent for the same number of early B-17 planes. These failures involved, or could easily have led to fires. Failure of electrical equipment also bulks large, and such failures can, in many cases, lead to fires. These two items together have accounted for 45 per cent of the accidents with the B-29 (as contrasted with 4 per cent for the early B-17's).

c. The accident record with B-29s shows 56 cases in the Continental United States (18 February 1943 through 30 September 1944). This total excludes gunnery accidents, "cook-offs", and the like. Of the total, 15 clearly and 2 probably involved engine fires, roughly 30 per cent. Engine failure without "fire" reported accounted for at least 6 more. Excluding 2 ground accidents (1 towing accident, and 1 due to maintenance error with a parked plane), we have 54 accidents in flight, of which 15 (plus 2 probables) involved engine fires, or at least 28 per cent.

d. Of the 54 accidents in the air ("c" group, above), 12 involved 69 fatalities. Among the 15 (or 17) engine fire cases, 15 involved fatalities. It is to be noted in addition, that the proportion of major injuries is high in the event of engine fire accidents.

e. There is little indication of fundamental improvement with time. Thus, in August 1944, there were recorded 9 B-29 accidents (2 resulting in 12 fatalities), of which 7 were instances of power plant failure and 2 involved fire in the air. In September, 14 B-29 accidents (within Second Air Force) involved 15 planes. Excluding 1 cook-off and 1 hit by lightning, we have 3 cases of engine fire, 1 electrical system fire, and 2 possible engine fire cases out of 13.

f. Available data on overseas experience (down to but not including first Anshan Mission) show 6 out of 36 "accident" cases or losses (not including 3 planes missing) with one or two engines on fire (16.7 per cent). Even including these figures, which embraces at least some combat losses, the total accident experience shows that at least one quarter of all the flying accidents with B-29s involve engine fires, with a high fatality rate.

2. The "Accident" data.

a. In attempting to evaluate the engine fire hazard, it must be realized that the official accident record is imperfect.

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Only "accidents" of a certain degree of destructiveness are recorded. Thus, if a plane with engine or engines burning is successfully landed on its own field without injury to crew and without burning off the nacelle, the occurrence does not appear in the accident record. I have witnessed such instances. This will be referred to in paragraph 2. Moreover, a significant number of cases has occurred in which more than one engine has been on fire. If for any reason one engine is "out", the call for extra power on the others imposed an additional risk.

b. The conventional "accident rate" figure, namely, the number of accidents per 1,000 hours of flying, has definite imperfections for analytical purposes. In certain respects it is useful when comparisons are made between two groups of planes of the same type under similar conditions of service. It can be very misleading when the performances of planes of different kinds are to be contrasted under necessarily different circumstances. At the present time the overall domestic "accident rate" for B-29s fluctuates in the neighborhood of 0.60 (in Second Air Force it is higher). It has declined from an initial high level, and the history of B-17 planes, now with a slightly declining "rate" near 0.30, indicates that (computed on this basis) it may be expected to decline slowly in the future. Since the time of occurrence of 25 accidents with each of these plane types, the over-all accident rates have followed pretty much the same declining course. The comparison is deceptive, however, unless a dissection is made of the relative frequencies of different types of "accident" occurrences, and of the respective roles of take-off, flight, and landing periods, which (so far as accidents are concerned) have not had the same significance for B-17 and B-29. Attention should also be given to the total numbers of airplanes involved, and of engines as well. For the purposes of this Report it is more important to deal with absolute numbers of accidents of a given kind, and with the proportion these are of the total number of "accidents". In this way, attention may be more easily focussed upon the causes of a particular kind of accident, and their possible eradication. For example, in the conventional classification of accident causes, a prominent category is "Pilot error"; another is "materiel failure". A particular engine fire might well be the result of poor management by the Flight Crew, or another due to structural inadequacy of a specific part of the engine. But if this general type of failure is of relatively frequent occurrence, it makes for practical purposes no difference whatever in which category of blame the accident is tabulated. The point is that the use of the airplane involves at every moment an interaction between human beings and the mechanisms of the ship. If the nature of these mechanisms is such as to impose a hazard in use, human deficiencies will only serve to accentuate the basic hazard. Engine failure, often with fire, and always with the risk of it in this or in another engine, is the largest, most significant single general cause of B-29 "accidents".

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c. For several reasons the data on B-29 accidents were first studied especially from the standpoint of experience within Second Air Force territory, and in part by means of personal visits to scenes of crashes with Headquarters Second Air Force AAAC investigating committees, other visits to B-29 bases, and many discussions with personnel, including men returned from CBI. The specific questions arise as to whether: (1) the large amount of work done upon this engine to improve its cooling has had a favorable effect upon the proportionate significance of engine failures; (2) if it is not possible that increasing experience of crews domestically, and especially overseas, has led to improvement in this respect. Useful light is had upon these matters by considering the results of the overseas employment of this airplane and then by dealing with the "accident" record since August 1944, in comparison with the previous record. Throughout, it has to be remembered that the official "accident" record is in some respects deficient as a sole source of information when the hope is to find the essential character of the basis for undesired, harmful features of a combination of man and machine. It is the "accident" which almost, but does not quite, happen to an extent justifying inclusion in the official record of "accidents" which can be much more useful as indicating the focal point of corrective attack. The essentially compound nature of the origins of "accidents" makes it necessary to bear in mind also, that the progressive minor modifications of the B-29 airplane, correcting one or another source of difficulty, have contributed to the ease and security of its operation; the net result of this, while (together with increasing general experience) reducing the conventional "accident rate", must only serve to bring into even greater prominence any fundamental weakness in the airplane as yet not corrected. The ultimate test can, in certain respects, be given by the behavior of the airplane as operated in combat zones, so far as concerns the revelation of specific weaknesses. Therefore, the combat Mission Reports have been examined with care, with special reference to the occurrence of engine failures such as have led, or might lead, to engine fires. The viewpoint used here is essentially that the study of failures in the performance of aircraft and crew, a kind of super-organism in itself, has in the present situation just one purpose: to discover specific functional weaknesses, so that they may be corrected. For this reason, the term "accident" should really be suppressed - it has no effective meaning. What is actually sought is indication of faults of design, construction, or operation, so that correction may be instituted.

3. Recent Operations.

a. The overseas operation of B-29's ("Foreign", and "In Transit") has involved a number of "accidents". As recorded in the official summaries, in the "Foreign" and "In Transit" fields, there were through 21 Apr - 23 Aug, 1944, excluding 2 cases with causes unknown, 11 out of 40 "accidents" reported as involving engine fires,



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or 27.5 percent. The parallelism with what has been already noted for domestic operations is curiously exact.

b. In the period Sep, Oct, Nov 1944, in the Foreign Theater, 2 out of 13 "accidents" about which something is known, or 15.4 per cent involved engine fire. In the domestic area, 8 (perhaps 8) out of 28 B-29 "accidents" (excluding taxiing mishaps and other irrelevant incidents) involved engine fire, or at least 25 per cent, occurred during Sep, Oct, and Nov. The significance of the details of the comparison depends upon an evaluation of the effect of sample size, nature of the records, fundamental adequacy of maintenance, and several other factors. The order of magnitude of the phenomenon of engine fires, in relation to other modes of accident, is not greatly improved.

4. Engine Failures:

a. The weakness of the B-29 power plant is plainly indicated by the fact that, from the U.R. files (probably not yet fully entered), in the period 16 June to 13 Sep, supplemented by other information to 26 Sep 1944, at least 139 (R-3350) engines were subjects of Unsatisfactory Reports. Among these, the median time since last overhaul was 70 hours; 48 (33.8 per cent) failed within 50 hours after overhaul. The median engine time since last overhaul for 13 cases (9.4 per cent) of engines on fire was 75 hours. Note that the median times are not significantly different - the period of median danger for the engine coincides with the median "age" period for incidence of engine fire.

The picture is a little better in detailed data from Clovis AAB, where in recent weeks a special maintenance program has been in effect. In the period Apr to July 1944, there were 28 cases of engine failure in flight, 25 to 325 hours after last overhaul; the mean time was 140 hours, 10.7 percent failing in the first 50 hours. In a more recent period, 22 June through 22 Aug 1944, there were 89 engine changes required (2 for fire in the engine, 2 for "chewed up" impeller, 37 for "swallowed" or failed valves). The median time since previous engine overhaul was 110 hours; 12.4 per cent of the failures occupied in the first 50 hours use since overhaul.

b. A report from Wright Aeronautical Corporation, 4 Sep 1944, available to Operations Analysis Section, Second Air Force, tabulates information about 394 B-29 engines dismantled for overhaul at O.C.A.S.C. in Aug 1944. In that Report, the averages of engine life for groups of overhauled engines are given. The forms of the frequency distributions for engine failure (among failed engines) are such as to cause the averages to present an incorrect picture of the situation.

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In the Wright Report data the median time to overhaul for the engines overhauled is ca. 90 hours. Thus, in the several sets of data available, 50 per cent of the engines that required overhaul failed at around 100 hours or less.

c. The statistical estimation of probable "danger periods" in the life of engines of a given type is perhaps best made in terms of a rate curve, exhibiting the percentage of engine failures occurring after various periods of service. With due attention to the establishment of confidence limits determined by the numbers of engines and of cases, such a graph would provide a Control Chart from which important indications should be obtainable. Correction being also made for the numbers and proportions of new engines (or, in general, for the age of an engine), it could be quickly told whether the statutory time for engine overhaul is correctly set for a given engine type under particular operating conditions, and whether Sub Depots are providing efficient overhaul. My colleague, Dr. P. G. Hoel, has made a preliminary analysis of this kind for P-47 engines (R-2800) in Third Air Force, which shows that the rate of engine failure begins to rise significantly at approximately 600 hours. Data for a comparable analysis in the case of B-29 engines are not presently available, and a real analysis of engine histories, however, desirable, is beyond the scope of the present inquiry. The indications obtained from information at hand are clear enough to emphasize the merely marginal safety of the B-29 power plant installation. The graphs in Annex III show that, in the 3 compilations of data available, 2 types of frequency distributions of (overhauled) engine failures occur. In one, the frequency drops rapidly with time since last overhaul. Even without knowledge of the total number of engines in use (as a function of time), this clearly points to inadequate maintenance. In the second type of distribution the frequency of failure rises to a maximum of 125-150 hours after overhaul. The suspicion here is that for the data in the second group a certain proportion of new engines is present. "Experience with another engine, R-2800 indicates an average of over 100 hours longer "life" for new engines). The median time-to-overhaul for 13 engines which had been on fire was 80 hours, although only 4 of these occurred within the first 50 hours. Again, as in the data of paragraph 2.a., this median time essentially coincides with that for the engine failures in general.

d. The predominant immediate cause of the engine failures in the 3 sets of data considered is exhaust valve failure. In the figures from the Wright Aeronautical Corporation Report certain possibly significant differences appear in the average performance by R-3350 engines built by different manufacturers. Thus, the Wright-built engines concerned (i.e., overhauled) had a somewhat greater average life after last overhaul (no correction made for the proportion of new engines), but 67 per cent of the failures were of exhaust valves (average time 201 hours); whereas Dodge-built engines showed 47.6 per cent valve failures (average time 140.5 hours);and C.C.A.S.C.-built engines showed 44.8 per cent valve failures (with average time 127 hours). The curiously exact proportionality between "hours since



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overhaul" and percentage of valve failures probably has a meaning, but detailed consideration of the individual records and better statistical treatment than is possible with the averages alone, would be required to discover it. In all probability, proper analysis with corrections for the proportions of new engines might eliminate the differences. The calculation of true rates of failure requires knowing the numbers of engines in use. There is no reliable indication here that the place of origin of the engines serves to explain through selective failure the high "morbidity" incidence in these installations.

e. A very rough estimate is possible here of the proportions of B-29 engine installations in service which fail each month. The point is mentioned because it may suggest a line of profitable quantitative inquiry. Even a partial knowledge of the number of failed engines suggests that with continued enlargement of the B-29 program, the point can easily be reached at which maintenance facilities will be saturated. Any approach to this point will almost certainly bring about further deterioration of maintenance quality, and thus an expected increase in the frequency of engine failures and of "accidents". It has been realized that an efficient analysis of accidents must be more clearly focussed upon prevention, through study of accidents which do not quite happen, - in other words, what might be termed the "accident potential" - rather than exclusively upon systematic classification of accidents that have already happened. The more detailed study of engine failures, as in the B-29, can serve as a type opportunity.

5. The Distribution of Engine Failures:

a. The distribution of engine failures with respect to engine position shows slight but probably significant differences between inboard and outboard engines. The record frequently omits the engine position. Among the 139 U.R. cases previously mentioned, where in 14 fire was present, and in many others overheating was certainly involved, the frequency of engine failure is in each of the four positions (44 with location not given):

| Engine | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Cases of failure | 21 | 29 | 24 | 21 |
| Percentage | 22.1 | 30.5 | 25.3 | 22.1 |

The excess of inboard engine instances may well reflect greater cooling difficulties there (wheel wells, supercharger installation); it is known that there is a real difference here. Data from a Report issued by Fourth Air Force on "Engine removals from B-24 Aircraft, February 15 - April 30, 1944" agree with these indications:

| Engine | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Percentage of failures | 23 | 26 | 27 | 24 |

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The effect is, therefore, not specific for the B-29 engine, although there it may be relatively greater. It is to be recalled, however, that failure of one engine in flight frequently implicates another engine through the extra load imposed.

b. Among the 15 plus 2 probably B-29 accidents with engine fire, the distribution among the engines is:

| Engine | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Cases of Fire | 7 | 5 | 1 | 6 |

Taking into account the frequency of occurrence of oil fires in #2, these figures suggest that the risk of engine fire is greater with the outboards.

c. When attention is directed to the recorded occurrences of fire in the induction system of the power plant alone (including cases not involving "accident"), the distribution is:

| Engine | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Cases of Induction System Fire | 6 | 3 | 1 | 10 (plus 2?) |

The preponderance of instances among the outboard engines (16 plus 2?) as contrasted with the inboards (4) is striking. It can scarcely be due to chance, or to differences in ease of observation for the onset of fire or hazardous heating. It is generally agreed that the cooling of the inboard engines is mechanically more difficult. It is very doubtful if the difference in number of generators can be responsible, and it is difficult to believe that a statistically systematic specific difference in maintanance could be involved. When a summary is made of all instances of "engine fire", the bulk of the cases with #2 engine are recorded as oil fires. A summary of engine failures not involving fires shows (in the U.R. records already mentioned) that the inboard engines show a definite preponderance of failures, in a ratio of about 2 to 1. The suggestion is possible that vibration of the outboard engine installations is greater than of the inboards. A not improbable manner in which this might contribute to the onset of impeller fires is discussed subsequently. The role of vibration in relation to oil lines and the like is, of course, understood.

6. Corrective Measures, General:

a. A fundamental difficulty with the B-29 engine installation is well recognized to be the inadequate cooling of the engines, in respect to the power demands upon them at present. Over-heating brings about a variety of conditions which can lead to fire. Strenuous efforts have, of course, been made to improve cooling-cylinder baffles; cuffs on propellers; readjustments of cowling flaps;

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changes in rocker-arm box design; crossover tubes; change in oil baffles. It is perhaps too early to determine whether these alterations will be fully effective, even when the fuel injection system is employed. Carefully studied directions have been devised which should decrease the risk of over-heating at take-off. It has been my personal observation that these directions respecting taxiing and warm-up time are not always followed. To the extent that they are successful, accidents and engine fires will be reduced. Only a careful analysis of engine deficiencies in terms of the age and history of individual engines can determine whether corrective procedures can remove the power plant deficiencies to a sufficiently satisfactory extent.

b. Those who work concentratedly to develop and maintain a particular piece of mechanism, especially in a difficult situation, are not unlikely to acquire for it a species of affection. This may be partially responsible for an attitude concerning the present B-29 engine installation shown by highly competent engineers and maintenance men. This attitude is summarized not unfairly in the quotation; "This is a good engine - if they would only fly it so as to keep it cool". It seems that this view neglects two main points, namely, (i) the power demands which have to be made under present operational conditions, and the effects of such demands upon engine life; and (ii) the single fact that one has no right to expect in actual Flight Crews the kind of experience level and the degree of engineering delicacy which can be derived from age and years of aeronautical experience with commercial airlines in peace time; with the hazards of combat missions added, realism requires the conclusion that the inherent factor of safety in the power plant will have to be very considerably increased before the risk of "accidents" can be greatly decreased.

7. Recent Experience:

a. Through August-November 1944, the total number of recorded "accidents" occurring in flight operation of B-29 airplanes, excluding gunnery accidents, has been 63; of these, 19 (18?) or 32 percent involved engine fires. It is noteworthy, and this general proportion has been maintained throughout, that in this period 28 other "accidents" involved what can fairly be indicated as engine trouble. Including the cases of fires in engine installations, 47 out of 63 "accidents", or 74.7 per cent were characterized as involving engine failure. It has been unmistakable that the engines are the weak point in the performance of the B-29 airplane. During December, in Second Air Force, of a total of 7 "accidents" in flight, 3 (- 43 percent), were engine fires.

b. The reports of "accidents" in the foreign area show that where engines have failed or have developed fire (the position of the engine concerned is not always given), the record of engine trouble is rather consistent with that to observed in the domestic data:

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| Engine No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Engine "trouble" or fire | 7 | 7 | 5 | 10 |

or a ratio of 17:12 for outboards as against inboards; for "engines on fire" the record, in the same order, is 3, 3, 2, 6. Fortunately, the numbers involved are small, so that certainly no real differences can be claimed. But the point has to be made that throughout the record of accidents involving engine failures, and the record of engine fires, just about 50 per cent of the "engine trouble cases" do involve engine fires. Thus, in the Foreign zone, 8 July through 23 August, 1944, eleven cases of "engine fire" are matched by eleven cases of recorded engine failure; from August through November 1944, of 30 B-29 "accidents", 15 involved engine difficulties without engine fires; and 8 (or 26.7 per cent) involved engine fires; the proportion of the total of engine troubles in accidents to the recorded "accidents" 23 out of 30, is in excess of 75 per cent. In these considerations, taxiing difficulties and gunnery accidents ("cook offs", and the like) have been excluded, for reasons which should be apparent. It is clear that the operation of factors referred to in 1, i, has served only to emphasize one major deficiency, relative to others, from a military standpoint, in the B-29 airplane: the inadequacy of the power plant.

8. In Combat:

On Missions of XX Bomber Command, considering only Missions 9-18 (26 Sep to 27 Nov 1944), the data are, from the present standpoint, not analytically simple. But this much is clear: some 108 instances of "engine trouble" are recorded, with 22 instances of engine fire. Where the position of the engine is given, tabulation shows:

| Engine No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| "Engine Trouble" | 29 | 20 | 30 | 28 |
| "Engine on Fire" | 5 | 4 | 8 | 4 |

The slightly greater incidence of "trouble" in outboard engines is noted, but it is not really significant in these figures - partly because instances are included in which "trouble" in one engine has been followed by "trouble" or worse with another.

9. Summary and Deduction:

a. In the period June to Nov 1944, inclusive, some 50.7 per cent of all B-29 "accidents" involved power plant failures; 20.2 per cent of the total concerned fires. In the period of Sep, Oct, Nov 1944, there were 15 cases of engine failure involved in reported accidents, and in 4 of these another engine also failed (26-6 per cent of the cases of engine failure in accidents). In earlier data, the proportion is higher, as high as 38.7 per cent.



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b. Since something like 50 per cent of legitimately labelled "accidents" in flight (including takeoff) involve engine failure, including propeller governor failures, and in about one quarter of these another engine on the airplane also fails, the conclusion is favored that, as in the cases of engine failure at takeoff, the engines are in general operating on too close a margin of safety as concerns the power they may be called upon to deliver.

C. Magnesium Fires.

1. Magnesium as a Fire Risk:

a. The role of engine failure, and the prevalance of the risk of engine fire is unmistakably indicated by the operational history of the B-29 airplane. In terms of the over-all frequency of occurrence of engine fires, these events present the single most prominent cause, immediate cause, of unwanted, disastrous occurrences ("accidents") with this airplane. There is to date no reliable indication that the various minor improvements introduced with respect to the engine and its cooling have affected the proportion of "accidents" experienced with this airplane which involve engine fires. Thus within territory of Second Air Force, during 1 Dec through 31 Dec, 1944, there were 7 real "accidents", and in 3 of them engines were on fire. A specific fire risk in these engine installations exists because of the presence of high magnesium alloys in the engine assembly. This is because of the notable flammability of magnesium alloys, and because magnesium fires are peculiarly difficult to control and to extinguish. Carbon dioxide, as in the extinguishing system provided in the aircraft, is definitely not an extinguishant for glowing or burning magnesium; on the contrary, it favors combustion.

b. In the R-3350-23 engine, the crank case front section, the supercharger front housing, the supercharger rear housing, the rear housing cover, are magnesium sand castings, with 89 to 91 per cent. Magnesium, 6-to 9 per cent; Aluminum, 2 to 3 per cent Zinc (AMS Numbers 4424, 4434, as of 12 July, 1944). A certain small number of structural parts of the aircraft are also made of magnesium alloys - in wheels and nose frame, for example. Typical magnesium alloys (as, AM 265) used for such purposes contain 4 to 6 per cent. Aluminum, 2 to 3 per cent. Zinc, and a small amount (about 0.2 per cent) of Manganese.

c. Solid magnesium metal melts at about 632°C, and the high-magnesium alloys at slightly lower temperatures. The "flash point" or ignition point, in air, is at about 600°C, varying with conditions of air circulation and other circumstances. Glowing of the surface depends upon various conditions, but (in air) is evident well below 600°C. In air the ignition point is usually given as at about 600°C.

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(1266°F). The exact temperature of ignition in a given test depends upon the nature of the metal surface, and under many conditions it depends upon the size of the area heated, in relation to the total mass of the metal and its temperature (the thermal conductivity of magnesium being high). Exhaust gas temperatures are as high as 950°C or higher. The equilibrium between magnesium and atmospheric oxygen in unstable; the film of oxide which forms on a magnesium surface is ordinarily a barrier to further oxidation under ordinary circumstances, at temperatures not too high. This barrier to ignition is not immediately present on a freshly fractured magnesium surface. There is a distinct possibility that the presence of traces of catalytically active substances, under suitable general conditions of temperature, may ignite a freshly scratched or scored magnesium surface. If the remainder of the mass is neither too large nor too cool, the heat of combustion of magnesium is so great, the reaction is so highly exothermic, that the burning spreads. The heat of combustion of gasoline is about 18,500 B.T.U. per pound; of magnesium 10,800; of celluloid 7,200; of thermite, only 1,400 B.T.U. per pound. It is an interesting matter that the two best incendiary materials known, gasoline and magnesium, should be found used in both aircraft engines and in incendiary bombs! In factory practice, the somewhat erratic manner in which magnesium being worked on a lathe, for example, will sometimes ignite while on other apparently similar occasions it will not, can perhaps be explained on the basis of the presence of catalytically active materials under suitable conditions. The apparently erratic manner in which some of these fires start enhances the more or less popular notion of the "erratic" behavior of magnesium as regards ignition, particularly when it is recalled that sheet magnesium alloy is regularly welded with a blow torch; in this case, however, a reducing flame is used which is surrounded by a cone of helium or argon gas with which magnesium does not react. The prevelance of fires in piles of magnesium turnings and filings, and in heat-treatment processes has been notable, and special precautions have to be taken to prevent their spreading. Grinding and polishing magnesium creates dust which is violently and often explosively flamable. A recent quotation from the National Board of Fire Underwriters summarizes the situation: "Magnesium is rapidly taking the place of celluloid as the most feared flamable" in industrial practice.

d. This general fact is not as widely understood as it should be. Commercial advertisements regarding the use of magnesium are very remiss in this respect. One pertinent example is an advertisement (Life, 11 Dec 1944) which states: "In England they save 1100 pounds of useless weight per plane just by turning to the use of magnesium for gasoline tanks, which the stress of war has proved to be amply strong and "utterly fireproof" (italics mine). This is not the place in which to discuss the fire risk in battle due to the presence of magnesium in military aircraft, but the topic is one requiring attention, and it is relevant to the present general question.



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2. Impeller Section Fires.

a. Four main types of nacelle fires are commonly recognized with B-29 aircraft: (i) exhaust stack and supercharger flight-hood fires, usually due to over-priming, too rich a mixture, or to oil collected in the exhaust; (ii) fires in front of the fire wall, commonly due to oil leaks; (iii) accessory section fires, due to leaks of fuel or oil, or to electrical causes; and (iv) fires in the induction system. The last are characteristically the result of back fires, which may signify primary trouble in the carburetor, the induction system, or in the ignition system. The number of such fires has been small relative to the total number of engines in use; but the actual number has been altogether too large; it is well-recognized that the situation is serious. In a number of instances it cannot be told just where a given fire began. But the incidence of what appear to be pretty certainly induction system fires, usually if not invariably associated with backfire, is sufficiently striking.

b. It has been pointed out that with respect to these, the outboard engines show a higher frequency than do the inboards. The reasons which can account for this are not entirely clear. The possibility which must be considered is that mass vibration of the whole engine is greater with the outboards. This may be significant in leading to contact between the impeller and the "throat" into which it fits (nominal clearance, not over 0.05 inch). The suggestion is that, particularly with a backfire, abrasive contact of the revolving impeller may serve to ignite the magnesium alloy of the impeller duct. The presence of small quantities of lead and lead oxide in the film which becomes deposited on the inner surface of this duct after some hours of service may be highly significant for ignition of the magnesium. If metal pieces, parts of broken valves for example, are backfired into the impeller duct, cutting of the magnesium alloy surface is almost inevitable. The sodium liberated from broken exhaust valves must also be recognized as a possible contributor to the initiation of induction system fires; its exact significance cannot be precisely estimated at present.

c. The internal origin of impeller section fires, coupled with the difficulty of managing a magnesium fire, makes it necessary to consider the advisability of providing for the delivery of fire extinguishing material as quickly as possible to the interior of the induction system.

d. Various possibilities have been studied with reference to the possibility of reducing the flamability of the impeller duct, such as: electroplating; smoothing and blackening the surface, to improve heat loss; and others. Since these processes are mechanically troublesome and of dubious efficacy under the conditions, it is concluded that they are not of special value. The technique of electro-



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plating magnesium, for instance is difficult, and there is no assurance that an electro-deposited coating would be fully adherent under the thermal conditions prevailing in engines; defects developing in the coating could have very serious consequences so far as concerns the starting of fires. For similar reasons, coatings with "flame retarding" salts or the paint loaded with magnesium oxide, while useful in certain other applications, are of little use in the present connection - particularly where quite high local temperatures may be concerned.

3. Extinguishants for Burning Magnesium.

a. There are two ways in which a fire can be extinguished: (i) by lowing the temperature of the flammable below the ignition point, (ii) by excluding substances with which the flammable can react with liberation of heat. The control of industrial plant magnesium fires (excepting heat-treatment furnace fires) has been upon the basis of preventing access of air. Powdered pumice, powdered coal, oil charged with $CO_2$, have been used; entectic fluxes of magnesium chloride and magnesium fluoride are used to deal with fires in casting operations. Even a sufficiently large stream of water, on an adequate volume of lubricating oil, can be used to reduce the temperature of a sufficiently small mass of magnesium below the ignition point. This factor of cooling has lead to some misunderstanding of the efficacy of certain proposed extinguishants, None of the methods mentioned is applicable to aircraft engines.

b. The relation of carbon dioxide to the extinguishment of magnesium fires is as yet not widely enough understood. Competent engineering officers, knowing that magnesium fires in engines sometimes are extinguished (with or without use of the $CO_2$ extinguishers), it has been held that when the gasoline fire "which is the source of the heat" has been extinguished by $CO_2$, the progress of the magnesium fire will be checked. The fact is, however, that carbon dioxide is a very much better oxidizing agent for hot magnesium than is atmospheric air. Glowing, on even sub-glowing magnesium blocks, burst into flame when the atmosphere is changed to carbon dioxide. This fact was noticed at the scene of an accident by Col. Herbert Morgan and Mr. Charles Foley, Operations Analyst, Second Air Force, Headquarters. This, together with the realization of the frequency of instances in which attempts to extinguish engine fires in flight, were found to be "ineffective" or definitely to lead to almost explosive acceleration of the fire, started the inquiry summarized in this memorandum. (Interim reports have been communicated to Operations Analysis Section, Headquarters, Second Air Force, and to Operations Analysis Division, Headquarters, Twentieth Air Force.)

c. Conferences were held with Professor A. B. Lamb, Director of the Chemical Laboratory, Harvard University, who has had direct knowledge of the industrial chemistry of magnesium; with

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with Professor L. B. Fieser, Harvard University, concerned with the use of magnesium in incendiary bombs; and particularly with the Factory Mutual Research Corporation of Boston and its Chief Chemist Mr. N. Thompson. Inquiries were also pursued with Dr. Francis C. Frary, Director, Aluminum Company of America Research Laboratory at New Kensington, Pennsylvania. A rather thorough examination of the problem of extinguishants for magnesium fires was undertaken. It resulted in the conclusion that anhydrous liquid ammonia is apparently the only likely extinguishant with mechanically suitable properties - cooling, extinguishing of oil and gasoline fires, and burning magnesium, transport as a liquid under comparatively low pressure. (Helium and argon do not react with hot magnesium at all, but since they cannot be carried as liquids it would be necessary to transport either of them in a bulky tank under a pressure of perhaps 2,000 psi; the battle risk is too great). A report on this subject was transmitted to Wright Field, Equipment Laboratory, under date 11 Sep 1944, from Factory Mutual Research Corporation. A copy is inclosed.

4. Firewarning Devices.

a. Early in this investigation it was suggested that effective use might be made of carbon dioxide in controlling impeller section fires if it could be delivered early enough to the interior of the duct. It was estimated that perhaps thirty seconds leaway might be available before a backfire would be likely to ignite the magnesium or bring it to a temperature at which carbon dioxide would be likely to induce combustion. This would require the use of an appropriate "flame indicator", either thermo couple (unless this should be found liable to giving false indications, as through carbonization) or the Minneapolis-Honnewell fire-warning indicator. It is understood (Newsletter, Twentieth Air Force, 11 Sep, 30 Sep, 7 Oct, 1944) that tests of this matter have been made, with satisfactory results, and that induction system fires have been extinguished in these tests by using as little as two (2) lbs. of $CO_2$.

b. It is desirable that if possible, effort be made to combine the installation of a flame warning device with automatic fuel and oil "cut offs."

5. Recommendations.

a. In the particular engine installation in the B-29, there is every liklihood that the presence of magnesium will always present a special fire hazard, or at least a source of trouble in the way of fire control, it is suggested that consideration be given to the replacement of magnesium components with aluminum alloy parts. With another engine it has already been found necessary to replace magnesium in manifold parts "to permit higher temperatures and more power". Attention should also be paid to the presence of magnesium castings in motors, generators, and other accessories.



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b. Until this can be done, a fire warning should be installed in the induction system, with provision for early discharge of extinguishant (carbon dioxide, or - depending upon current tests, perhaps anhydrous lieuid ammonia) into the induction system.

c. One finds it very difficult to avoid the conclusion that the only sound solution is to replace the present power plant installation with a more powerful one, not forced to operate so close to the limits of breakdown.

d. It is urged that if any real progress can be made promptly in the direction of engine fire control, the fact be given the widest publicity in the Twentieth Air Force. The morale of flight crews is definitely bad with respect to the fear of engine fires in flight. This I know from personal observations; it is confirmed by the testimony of others, in Second Air Force, and returned from XX Bomber Command. The men regard B-29 engine fires as the greatest unsolved problem in the operation of this aircraft. The reactions range from deep concern to real fear; they account for the readiness with which possibly landable aircraft are quickly abandoned in the air, and sometimes (one gathers) with some confusion. Greater emphasis upon practice with emergency procedures is needed in training; and the establishment of a system of fuel transfer in which, confidence is felt, would improve this situation somewhat. The greatest need, however, is for an effective means of preventing engine fires, or at least of controlling them. Undoubtedly, much of the flight crew "error" in emergencies involving engine failure is due to the fear of engine fire. This should be removed as soon as possible.

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24 Jan 45
WJC/ma/4819

COMMENT ON COMMUNICATION FROM GENERAL POWERS, IN REPLY TO GENERAL WILLIAMS' LETTER.

1.a-General Williams' letter of 8 Jan 45 gives an accurate picture of the situation as I have seen it. Within Second Air Force, through 1 to 19 Jan 45, there have been 11 B-29 "accidents" in flight; one of these planes was lost; of the 10 others, about which something is known, 6 involved engine fire (in 2 of these, fire in one engine was followed by the loss of power in or failure of another engine). Even in this small sample, the proportions of engine trouble continue to be of the usual magnitude. In these fire incidents there were 10 fatalities, 13 major and 8 minor injuries.

b-With present overall frequency of B-29 "accidents" and the consistently maintained proportion of them involving engine fires, it is not difficult to foresee that by July or August of this year, something like one "accident" per day of this type must be expected - unless the engine fire hazard is reduced.

2. It is noted that General Williams calls attention to the morale of crews as being badly affected by the B-29 engine fire hazard, and to the consequences of this; the matter has also been referred to in a recent Memorandum from Operations Analysis Division to Chief of Staff, Twentieth Air Force.

3.a-In my contacts with Wright Field on this matter of magnesium fires, and fire warning devices, I have failed to discover any sense of "combat urgency". As a matter of fact, it has been known ever since the time of the fire-in-flight on the very first B-29 test-flight (18 Feb 43) that the $CO_2$ system is unable to control burning magnesium. Why proper consideration was not promptly given to the elementary chemistry of magnesium is very difficult to understand. As late as 7 June 44 (Flying Safety Memo. No. 7, "Power plant failures in B-29 Accidents"), the best specific suggestion provided was: "After a study had been made of the direction of air flow within the nacelle, the $CO_2$ fire extinguisher outlets should be relocated in an area close to the source of incoming air." At this time, there seems to have been no effective knowledge of the nature of impeller section fires, nor of the properties of magnesium; no mention is made of these topics in the CAA Bulletins on "Fires in Flight" as late as Oct 43.

b-Fire warning devices intended to give prompt notice of fire, particularly in the impeller duct, together with arrangements for dumping $CO_2$ into the induction system, were urged as early as August 44, by Colonel Herbert Morgan, Jr., then Chairman of Committee on Flying

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Safety, Second Air Force, and myself; and on several visits to Wright Field (Sep, Oct 44) I endeavored to push their testing. Up until the last few days, this project was on a very low priority.

c-In General Powers' letter it is apparent that the effect of $CO_2$ on sufficiently hot magnesium, not actually burning, seems not to be understood. The actual number of cases known in which "pulling" the $CO_2$ extinguishers has resulted, not merely in failure to extinguish the fire but in the ignition of the magnesium with consequent invigoration of the engine fire, is more than suggestive.

d-The suggestion of jettisonable engines was made by Colonel Morgan and by myself, in June 44. It still has a certain merit, I believe. (At that time there was the added thought that pitching characteristics of B-29 might be improved by dropping the engines, or two of them. This seems now not so important.

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FACTORY MUTUAL RESEARCH CORPORATION

184 High Street, Boston, Mass.

September 11, 1944

Commanding General,
AAF Materiel Command,
Engineering Division,
Equipment Laboratory,
Wright Field,
Dayton, Ohio.

Attention: Col. G. V. Holloman, Chief,
Equipment Laboratory, Engineering Division.

Subject, - Ref: Dept. 54-5
Magnesium Fire Extinguisher.

Dear Sir:

We have developed a method and facilities for extinguishing fires in magnesium or its alloys inaccessible locations by the use of liquid anhydrous ammonia, - used either with or without simultaneous general screening or flooding with carbon dioxide. In order that this method may be applied effectively, it is essential that the ammonia be conveyed to and discharged onto the burning magnesium in the liquid phase.

We have made tests in which scrap magnesium of various cross-sections was ignited by means of a magnesium incendiary bomb such as the M-50. If ammonia is applied as a gas, a reaction still continues although at an obviously reduced rate as compared to air. On the other hand, as soon as liquid ammonia is sprayed onto the burning metal, extinguishment is apparently almost instantaneous, - due to the high cooling or quenching effect obtained from the heat of vaporization of liquid ammonia.

In our development of this extinguishing agent, there were several factors considered. For example, the very best extinguishing agent should be inert to hot magnesium, it should have a high cooling or quenching power, it should be noncombustible, it should be noncorrosive, it should be non-irritant and non-toxic, it should be available as a liquid or liquefiable gas in order to conserve space in storage and transport, it should be a liquid or gas in order that it might be easily applied to relatively inaccessible locations, and it should have a sufficient vapor pressure to convey it through pipes or nozzles and thus avoid auxiliary pumps.

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Commanding General,
AAF Materiel Command

September 11, 1944

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Of all the materials which might be considered as fire extinguishing agents, liquid ammonia is the only one that most nearly fills these specifications. While ammonia in the gasket form is dissociated at high temperatures, the subsequent reaction between magnesium and the nitrogen produced is not excessive in view of the short periods of time during which the ammonia gaseous phase may be present. The quenching power of liquid ammonia is exceeded only by that of water, which reacts vigorously with burning magnesium. Ammonia, while not entirely non-combustible, has a relatively low order fire-hazard as compared to any other materials which are inert to burning magnesium. Ammonia gas is both irritant and possibly somewhat toxic, so that its use is not advised where the vapors cannot be adequately disposed of.

Gaseous ammonia will ignite and burn when mixed with air only under the most favorable conditions of air-mixture ratio and of high temperature ignition source. In confined locations where there might be some damage from the combustion of ammonia together with its dissociation products or where there might be some danger of a flash creating pressure, we suggest that the volume be initially purged for a short period of time by the usual carbon dioxide flooding system, after which the liquid ammonia can be applied directly to the magnesium fire with perfect safety. Even when ammonia gas and dissociation products are allowed to burn freely without using any carbon dioxide, the temperatures produced are insufficient to ignite magnesium metal in thin sections, at least within any period of time which possibly could be necessary for extinguishing a magnesium fire well under way. However, the heat produced would be sufficient to ignite hydrocarbon oil, wood or textiles, and to char electrical insulation materials. With a properly designed system, however, where only a small amount of ammonia gas is produced over a short period of time before the ammonia liquid is discharged onto the burning metal, the fire and heat from the burning of gaseous ammonia in air, is quite insignificant. To determine whether or not screening by carbon dioxide would be necessary would require a careful analysis of the conditions and possibly confirming tests.

Attached to this letter, we are enclosing a data sheet giving some significant figures in regard to compounds of magnesium and agents which might be used as possible fire extinguishers:-

You will note that in the column giving data on heat of formation, the energy figure for magnesium nitride is not only lower than those of the oxide and chloride, but based on a unit weight of magnesium metal or a unit volume of the gas in question, the figure is very much lower.

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You will also note that as regards cooling capacity obtained from the vaporization of the material in the liquid phase, ammonia is only exceeded in this capacity by water; and its cooling power is several times that of materials quite inert to burning magnesium such as propane or butane. The heat of combustion per unit volume of the material in gaseous form is about six and one-half times as much for propane as for ammonia, even assuming ideal conditions for complete dissociation (which rarely exist).

The other materials listed such as carbon dioxide, water, sulpher dioxide, and carbon tetrachloride, all react very vigorously with burning magnesium, so by themselves are of no value in this problem.

Briefly, the method which we have developed utilizes commercial anhydrous liquid ammonia stored in steel cylinders with iron valves and fittings, a piped supply to spray nozzles designed to distribute the liquid ammonia directly onto the burning parts, means for remote manual or automatic operation of valves so that the liquid ammonia will be forced by its own vapor pressure to the nozzles and through them be ejected preferably in a well distributed liquid spray onto the burning metal. The application of liquid ammonia to a fire involving magnesium metal will depend upon the maximum probably progress of the fire and more particularly upon the cross-section or weight of the metal which must be cooled in order to bring the magnesium below its ignition temperature. Based on our test work to date, admittedly incomplete, we would estimate that for average conditions where a fire may occur in magnesium with sections as heavy as 1/2 inch thick, it might be necessary to apply liquid ammonia at the rate of 5 lbs. or possibly somewhat more per square foot per minute. However, in all our tests in which the liquid ammonia has been used, the fire has always been extinguished in less than five seconds, so that the supply problem for ammonia in the liquid phase does not appear serious.

The foregoing seems unusually lengthy, for which I apologize, but I am unable to explain this method otherwise. It is hoped that this information will help you in your problem; and I wish to assure you that we will be glad to cooperate in the design or testing of any practical applications of this system.

Very truly yours,

NJT:RL 7
cc Dr. Wm J. Crozier
c/o Operations Analysis,
AD-150 Pentagon Bldg.,
Washington D.C.

FACTORY MUTUAL RESEARCH CORPORATION

(Signed) NORMAN J. THOMPSON
President

Enc. Copy Data Sheet.

THIS IS A TRUE COPY:

WALTER G. de STEIGUER, Lt. Col., A/C

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July 24, 1944

Significant Data to the Extinguishing of Fire

in Magnesium and Its Alloys.

| | Heat of Formation - Cal. per gm mol. wt. | Heat of Vaporization - Cals. per Gram | Heat of Combustion - Kg. Cals per gm. mol. wt. |
|---|---|---|---|
| Magnesium Oxide ($MgO$) | 145.8 | | |
| Magnesium Nitrade ($Mg_3N_2$) | 118.3 | | |
| Magnesium Chloride ($MgCl_2$) | 153.2 | | |
| Ammonia ($NH_3$) | 10.9 (gas) | 302 (0°C) | 86.7 (gas) |
| Carbon Dioxide ($CO_2$) | 94.4 (gas) | 55 (0°C) | |
| Water ($H_2O$) | 57.8 (gas) | 595 (0°C) | |
| Sulpher Dioxide ($SO_2$) | 69.3 (gas) | 91 (0°C) | |
| Carbon Tetrachloride ($CCl_4$) | 25.4 (gas) | 46 (77°C) | |
| Propane ($C_3H_8$) | | 89.6 (0°C) | 526.3 (gas) |
| Butane ($C_4H_{10}$) | | 91.5 (0°C) | |

Note: Magnesium does not form a hydride.

Data from 25th edition of Handbook of Chemistry & Physics - Chemical Rubber Publishing Co.

Norman J. Thompson

THIS IS A TRUE COPY:

WALTER G. de SIBIGNEA
Lt. Colonel, A/C

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

9 Feb 45
WJC/ma/72993

MEMORANDUM TO DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: B-29 Fire Extinguishers

1. The Conference on B-29 power plant fires at ATSC, February 5, 1945, was unsatisfactory due to the fact that the domestic using agencies were not represented.

2. As a result of this Conference, and of further inquiry at Wright Field, it is urged that:

A major decision be made to have installed the fully-developed $CO_2$ fire extinguishing equipment, with seven 12.5 lb. $CO_2$ shatter proof bottles, induction system fire warning devices now fully tested, and instrument panel warning lights. This system carries a "weight penalty" of approximately 307 lbs. per airplane. There is a possibility that tests can provide a means of compensating for this weight increase by eliminating wing-deicer accessories. It must also be kept in mind that unless effective fire control equipment is provided, more than this weight-equivalent of bombs will be lost anyway. The installation could be begun within eighth weeks (Boeing, Denver), we have been assured.

3. It cannot be assumed that engine improvements will ever make fire control equipment unnecessary. The evidence indicates that the present B-29 $CO_2$ installation could be best used to dump $CO_2$ into the induction system. This change, involving the installation of fire warners, is comparatively simple. Unitl fully adequate extinguisher devices are installed, the morale benefit from this "stop gap change" would alone be considerable. It should be ordered.

WILLIAM J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

3 April 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject; B-29 Engine and Nacelle Fire Control

1. On a recent visit to Boston, I was able to consult with Factory Mutual Research Corporation, now working under a high priority contract through ATSC to make a general evaluation of fire extinguishment problems and methods, with special reference to engine fires. I believe that good progress is being made. They are somewhat handicapped by the manpower situation, particularly in the case of one of their best young research engineers who is caught in the draft. Experiments and the collection of relevant information are proceeding, and good cooperation by ATSCis reported.

2. There is attached copy of Boeing B-29 change 887 or 887M, indicating that as of 9 March one of the fire-protection changes desired is underway. (I had been under the impression that a "flame detector" other than the "Midget" model of Penwall manufacture was planned for; this may perhaps be changed later).

3. (a) It had been announced at the Wright Field Conference that there was under consideration for the very near future, the installation of a separate feathering pump operating on a reservoir of hydraulic fluid (rather than using engine oil). In conversation with Mr. Gillett, I was reminded that hydraulic fluid is inflammable. In the discussions at Wright Field, the phrase "non-inflammable hydraulic fluid" had been used, and I did not pursue the matter then. Inquiry shows that the currently used hydraulic fluid is "Hydraulic oil AN*VV*O*366B", which has a flash point minimum of 93.3°C (=200°F). This oil has been recommended for the separate propeller feathering system. The inflammability of the hydraulic fluid is perhaps a most serious hazard under conditions of battle damage, so long as it is uded only in the regular hydraulic system. If it is also used in the engine nacelle, other possibilities are apparent.

(b) Information from Boeing Company states that they "have no information available concerning use of non-inflammable fluid," but they believe that investigations in this direction are being made by ATSC. I am informed that an R & R has just gone out from

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Twentieth Air Force Headquarters to ATSC on this matter. The Factory Mutual Research Corporation is also, at my request, looking into possible non-inflammable hydraulic fluids. It has been pointed out (by Mr. Gillett and others) that the newly developed "silicones" or the hydrocarbon fluorides, may influde substances having the necessary fluidity - temperature properties and non-corrosive qualities essential for the suggested use; some of these substances are very fire-resistant.

4. I am informed by Boeing Company engineers, as of 24 March 1945 just received, that ATSC, in conjunction with CAA, will "completely fire test a B-29 power plant installation at Indianapolis." I have been given to understand that "various types of fires will be simulated and their progress studied." I am worried about this. I am in doubt about the effective degree of "simulation" of flight conditions. I am also curious as to who is going to evaluate the results of these tests? It would be very interesting, and unquestionably important, to know exactly what it is proposed to "test." I have reason to believe that the Factory Mutual Research Corporation has not been informed of these tests, although they are currently pursuing a "high priority" contract on the same topic. Of course, there may be sense in having independent checks, but common sense would suggest that joint effort and mutual understanding might well save time in this already too long delayed business. The thought may be suggested that if sufficiently "war weary" B-29's become available, real tests of fire extinguishing equipment should be made in the airplane (on the ground).

W. J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

19 February 1945

MEMORANDUM TO DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: B-29 Engine Fires

1. This morning I gave you a brief tabulation of the numbers of B-29 engine fires occuring in reported accidents, for the recent period. The point had to do with the numbers of these occurrences in the domestic area and overseas. These were listed in terms of "engine fires" as percentages of all reported accidents. These figures do not by any means give an adequate picture of the situation. As is well known "accident" has various meanings; moreover, not all engine fires are reported as "accidents."

2. Boeing Field Representatives report (Ref: Boeing Document D-6310) 15 engine fires at India Bases during 1944. In the same period of time as concerned for these overseas fires, there were 2 in Gipsy Task Force, 59 in the U.S. (46 in Second Air Force).

3. A recent Operations Analysis Section Report from the XXI Bomber Command lists 12 out of 30 sea ditchings where interrogation of rescued survivors gave information as to the circumstances. Engine fire was present in 4 of these 12 cases. Study of abortive sorties in 73rd Wing Mission Reports for major Missions 7 through 17, shows 4 additional cases (not involving ditching).

4. The creation of and "accident rate" or index suitable for comparing certain aspects of aircraft performance under different conditions of operation is of course, far from a simple matter. The histories of these fires show that 95 per cent of them occur within the first 2 hours of flight, more than half during the first 10 minutes of flight. Under combat conditions this distribution does not hold clearly; the general indication is that the risk of fire is greatest when there is demand for maximum power. Nevertheless it is pretty clear that calculation of a fire incidence index in terms of hours flown is not very useful. It is better to consider the frequency of engine fires in terms of sorties flown.

5. a. In Second Air Force, during 1 December 44 through 2 Feb 45, there were listed 5,584 B-29 sorties(training), and in theis period there were 6 reported engine fires. Domestically there were a few

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other B-29 sorties, but we may take these figures to give about 1.08 fires per 1000 sorties.

b. In the records of 73rd Wing, 9 major missions from No. 7 through No. 16 involved 590 sorties; in these 5 engine fires are reported - a "rate" of 8.5 per 1,000 sorties. In this same period, at least 3 other fires occurred, as revealed by the ditching record. A certain number of planes are missing, and about them information is largely lacking. Also, it is not clear that some engine fires reported over the target were started by enemy missiles.

6. It appears that in combat theaters the relative significance of engine fires is less in proportion to reported "accidents" as a whole than in the domestic area. This might be expected, despite the higher experience-level of crews. But it is definitely not the case when the frequency of fires is considered as a function of the number of sorties flown. At the moment, the comparison can be made (from data at hand) only between Second Air Force experience and combat mission experience; it would be valuable to have data relative to non-combat flights as well.

W. J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

6 March 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: B-29 Engine Fires

1. It seems to me worth noting the February 1945 status of B-29 engine fires, in terms of the units used in my previous Memoranda. These units are not quite the same as those employed in the excellent summaries prepared by OFS; they are intended to focus attention on occurences in flight - consequently, bumps during taxiing, "Cook offs," results of maintenance crews' misfortunes with the aircraft at rest, are excluded. Certain important comparisons involving numbers of sorties (rather than "time flown") are not yet possible, since information is incomplete.

2. On this basis, we have 23 "accidents" in all, domestic, foreign and late-reported; the circumstances concerning one of these are unknown; in twelve, power plant failure was involved - 54 percent of the occurences; in four, engine fires were involved (18 percent).

3. In the domestic theater alone, twelve accidents in flight involved eight power plant failures; three, engine fires (25 percent), The proportion of involvement of engine failures and of engine fires to other types of "accidents," at takeoff, in flight, and in landing, has not decreased, domestically.

4. The number of "foreign" and of "newly reported" pre-February "accidents," is too small for indications to be significant. We have one engine fire in twelve incidents, and in all three reported power-plant difficulties. These proportions are not significantly different from those mentioned in Paragraph 3.

5. No data are as yet at hand permitting adequate indication of the frequencies of power-plant failures and of engine fires in fully modified engines, as of this date, in comparison with these frequencies in older editions of the power-plant. Some light is thrown on this by study of abortive combat sorties (considered in a following Memo). But this much is clear; power-plant weakness is the major single cousre of B-29 difficulty. Consideration of the data from any standpoint shows this. Consequently, this is the unique place where improvement can have the most significant effect in efficiency of operation. This remains true even though the number of these A/C in use, and the number of sorties, is increasing.

W. J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

18 May 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: B-29 Engine Fires and Engine Position

1. In response to telephoned inquiry from Major McIntyre, the following data are presented with reference to the distribution of B-29 engine failures and engine fires:

a. In data available up to mod-December, the distribution of engine failures was (Memorandum, 5 Jan 45, J. W. Crozier):

| Engine | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Cases of failure | 21 | 29 | 24 | 21 |
| Percentage | 22 | 30.5 | 25.3 | 22.1 |

For engine fires the distribution was:

| Engine | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Cases of fire | 7 | 5 | 1 | 6 |
| Induction-system fire | 6 | 3 | 1 | 10 |

b. A study by Engineering Department, Boeing Aircraft Co., 1 Feb 45 (Boeing Document D-6310) of data on 90 engine fires showed these locations:

| Nacelle | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Cases | 24 | 25 | 15 | 23 |

The total to 1 May 45 is:

| Nacelle | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Fires | 30 | 28 | 21 | 31 |

Outboard engines - 61, or 68 per cent
Inboard engines - 49

| Nacelle | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Induction system fires | 12 | 9 | 5 | 12 |

W. J. CROZIER
Operations Analyst

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FOR VICTORY BUY UNITED STATES WAR BONDS and STAMPS

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11 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Query of Earlier Date Regarding "Battle" Tests of Magnesium Control Surfaces.

1. Some time ago I submitted a suggestion to the effect that an air firing test be conducted to determine the behavior of Magnesium alloy sheet metal control surfaces subjected to risks of battle damage. Attention was called to the properties of certain Japanese planes. I wonder what response was obtained.

2. At the recent meeting of American Society of Mechanical Engineers in New York City, J. C. Mathes of Dow Chemical Company, described the use of aircraft wings of Magnesium (account in: Christian Science Monitor, Boston, 5 Dec 1944, p.3). Such wings were described as stronger and lighter than standard Aluminum wings and than wings of low-carbon steel, stainless steel, plywood or other materials (14 percent lighter than Aluminum wings). The speaker said: "If we can save a few hundred pounds of plane weight we can carry that many more pounds of payload with no increase in operating costs. The saving of a single pound has been estimated as worth $100 a year on a commercial plane".

3. The attitude revealed in this quotation reflects, I am pretty sure, a definite current commercial policy to exert pressure for the widespread use of Magnesium. The extensive popular advertising now visible in magazines substantiates this opinion. There is a cruel lack of thought displayed in this policy, because (at the kindest) it displays no knowledge of the fire hazards of Magnesium. The most immorally flagrant instance, perhaps, is found in an advertisement (Rever Copper and Brass Inc.) appearing in current issues of "Life", "Saturday Evening Post", etc. from which I quote: "In England, they save 1100 pounds of useless weight per plane (what plane? war plane?) just by turning to the use of Magnesium for gasoline tanks, which the stress of war has proved to be amply strong and utterly fire-proof". (Italics mine).

4. As it stands, this statement is, of course, completely untrue. I wish that information could be had as to battle experience with these British installations. It is scarcely humorous when one recalls that gasoline and Magnesium alloy are the essential constituents of incendiary bombs.

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5. It may be that someone has discovered a method of fire-proofing Magnesium alloys (but the objectionable statement just quoted would still be untrue!). If such a method has been found, it is as yet unknown to the industrial chemists who have become increasingly concerned about the fire hazards of Magnesium; their attitude is fairly represented by a remark made to me by one of them last week, in commenting upon the advertising campaign: "Well, the heat's on - the boys have Magnesium to sell, and there is going to be a lot of trouble".

6. In this general connection, I have noted that the Dow Magnesium Wings have been worked out with the Navy since 1940; some 30 sets of wings are said to have been installed on North American Aircrafts trainers in 1943, to have been in regular service, and to have been "entirely satisfactory". It would be interesting to have further information on this subject - with reference to corrosion, for example, especially if used in the vicinity of salt spray.

7. Magnesium has been used, or tested for use, in the strangest places: in the interior of fuel, oil and cooling-fluid gages, where it corrodes and causes trouble (see AAF Board Project I-3997); for rocket-launching tubes (of all things!) as in AAF Board Project 3790-C - which seems to correspond to Projects F-4097 and 3805-C, where the "Magnesium" has been dropped and "Aluminum" inserted.

8. The peculiar ignitability of Magnesium alloys and the special difficulty of extinguishing its fires, matters which are definitely less widely known about than they should be despite the superlative qualities of these <u>same</u> alloys for use in incendiary bombs, raises a number of pointed questions for aircraft design. Mere insistance on weight reduction should not cause the danger from fire, nor the corrosion difficulties, to be lost sight of.

W. J. CROZIER
Operations Analyst

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OFFICE OF THE COMMANDING GENERAL
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By Authority of
The Commanding General
Army Air Forces
3 Jan 45 R.L.S.
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

3 January 1945

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Digest of Instances of Mechanical Failure B-29 Aircraft in XX Bomber Command

1. Mr. Ward McLaren, Operations Analysis Section, XXI Bomber Command, has suggested that it would be helpful to have a brief digest of the instances of mechanical failure most frequently encountered with B-29 aircraft in XX Bomber Command. The Mission Reports from XX Bomber Command (through Mission 19, 7 Dec 1944) give somewhat detailed information, particularly with reference to "malfunctions of equipment" and their interference with delivery of bombs on primary target. A summary of some outstanding points is given. The records are in some matters of detail hard to use, since the categories of troubles are not uniform in the several Reports; in some cases the categories are not broken down in sufficient detail. Particular attention is given to the data on Missions 15 to 19 inclusive, 5 Nov to 7 Dec, as indicating the current situation in XX Bomber Command. The purpose of summarizing the information, as requested by Mr. McLaren, is to help to build up a guide for preventative maintenance.

2. The data summarized from the Reports have been discussed with Mr. G. Williams, Boeing Company Representative, Operations Analysis Division, Twentieth Air Force. He has dispatched a message to Boeing Company, Seattle, containing the gist of this information and suggesting that further information, in certain respects more specific, might be gathered by Boeing Field Representatives. For example, it is desirable to have data relative to non-combat flights. Possibly Statistical Control sections could be utilized. It is possible that Operations Analysis Section personnel could undertake analyses of maintenance records. If trends of instrument failures can be detected, corrective measures can be made more intelligently and even to some extent in advance, by use of simple principles of statistical control. At the same time, the directions of effort in inspection which are likely to yield the largest results can be more easily seen.

3. (a) Table I summarizes the chief information from XX Bomber Command Mission Reports 9 to 19 inclusive (26 Sep-7 Dec). Of 916 aircraft airborne on these missions, 162 or 17.7 percent failed for reasons

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mechanical failure or difficulty to bomb the primary target. In the "October group" of missions this percentage was, 15.4; in the "November group", 18.8 percent.

b. With the 916 airborne aircraft, 1317 "malfunctions of equipment" were experienced, an average of 1.44 per airplane. The proportion is higher for November than for October (1.77 as against 1.12). Whether this reflects primarily the influence of bad weather and of stepped up mission frequency in November, can scarcely be said with certainty. Maintenance difficulties of other kinds might also be involved.

c. In the list of mechanical difficulties, a prime place is, of course, occupied by "power plant and accessories". This is further emphasized by the history of the planes which were unable to take off on mission; of these, in Missions 9 to 19 inclusive, there were 121 (excluding Mission 18), 12.4 per cent of the total prepared to take off.

d. The high frequency of troubles with tachometers, temperature gages, and in general of "instruments", is noteworthy. It would be desirable to know more precisely the nature of tachometer failures, for instance, as an aid to discovering if they could not be improved.

e. It is notable that blisters continue to be blown out. On Mission 19, 11 of these incidents are recorded (together with 10 failures of the defroster system).

f. The weakness of the oil system stands out, and the fuel system as a whole, seems to be causing increasing trouble.

W. J. CROZIER
Operations Analyst

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ST FREQUENTLY REPORTED DIFFICULTIES WITH EQUIPMENT ON MISSIONS 9-19 OF XX BOMBER COMMAND

| Mission | (26 Sep) 9 | 10 | 11-12 | 13 | 14 | (5 Nov) 15 | 16 | 17 | 18 | (7 Dec) 19 |
|---|---|---|---|---|---|---|---|---|---|---|
| Take-offs | 236 | 255 | 102 | 207 | 49 | 75 | 212 | 238 | | 231 |
| Failure to be airborne, mechanical causes | 15 | 12 | 18 | 36 | | 1 | 12 | 14 | | 15 |
| Airborne on Mission | 109 | 130 | 102 | 78 | 49 | 75 | 96 | 109 | 60 | 108 |
| Failed to bomb primary target, for mechanical causes | 19 | 16 | 18 | 14 | 5 | 20 | 28 | 22 | 4 | 16 |
| Aircraft with mechanical difficulties affecting missions | 43 | 57 | 38 | 42 | | | | | | |
| Malfunctions of equipment | 125 | 156 | 82 | 74 | 85 | 149 | 168 | 164 | 100 | 214 |
| "Power plant and accessories" | | | 10 | | 14 | | 13 | 19 | | 14 |
| Propeller and governor | 12 | 10 | 7 | 9 | | 7 | 6 | 24 | 5 | 12 |
| Tachometers | 20 | 27 | 16 | 13 | 7 | 9 | 21 | | 15 | 24 |
| Oil leaks | 18 | 22 | 8 | 8 | 4 | 10 | 14 | | | 20 |
| "Oil system" | | | 5 | | | | 33 | 23 | 7 | 49 |
| Generators | 11 | 10 | 14 | 4 | 2 | 11 | 9 | | 5 | 8 |
| "Electrical system" | | | | | | | 22 | 17 | | |
| Cylinder-head temp. gages | 11 | 14 | 6 | 7 | 5 | 8 | 10 | | | 8 |
| Carb. air temp. gages | | | 4 | 4 | 3 | 3 | 12 | | | 6 |
| "Fuel system" | | | | | | | | 15 | 10 | 10 |
| Fuel pressure gage | | | 2 | 3 | 0 | 2 | | | | 5 |
| "Instruments" | | | | | | | | 38 | | |

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

6 Feb 45
WJC/ma/72993

MEMORANDUM TO DR. ROBERT L. STEARNS

Subject: Supplemental Note on Service from R3350-23, 23A Engines in B-29 Aircraft

1. Information extracted from the "Monthly Analysis of Aircraft Engines Disassembled at Overhaul Activities....." (Statistical Control Office, Headquarters ATSC, Wright Field) supplements for the month of October last (published 1 Dec 1944) the indications (Through September 1944) given in my memorandum on Engine Fires. Subsequent data will be examined from this standpoint when they become available.

2. The data refer to 360 domestic area engines overhauled for various reasons during October. Of these only 21 were overhauled because the "allowable operating time" (400 hours) had been reached. In the domestic area, the average number of hours elapsed since last overhaul was 188 hours, which is 47 percent of the "allowable operating time." Overseas engines overhauled in the United States numbered 224, averaging 163 hours of 41 percent of "allowable operating time." Taking out the 21 domestic area engines which had arrived at full time, we find the "mean life" since last overhaul to be approximately 175 hours.

3. It has been pointed out (in my earlier memorandum) that the mean "life" is not a very efficient way in which to describe the situation; the median life expectancy, namely the elapsed time since preceding overhaul at which one half of the engines concerned have had to be dismantled, is much more significant. "The reason for this is that the frequency distribution of engine "life-time" is highly skewed; a few good engines will conceal the behavior of the majority. A fuller examination of engine life data is now being made). But a certain comparison can be made with similar information on B-17 and B-24 engines in the same month:

B-29 (R-3350), mean time since last overhaul - 188 hours
B-17 (R-1820), mean time since last overhaul - 564 hours
B-24 (R-1830), mean time since last overhaul - 499 hours

4. The reasons assigned for dismantling these engines have been classified:

a. Manufacture ("improper design," faulty material, imperfect manufacture of the engine proper).

b. Improper operation.



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c. Faulty maintenance.

d. Faulty overhaul.

e. Allowable operating time.

f. Other reasons.

The table indicates the numbers of engines in these several categories, with the manufacturing or overhauling agencies. It shows the "new" engines average longer life, but that 56 percent of the overhauls (excluding those run for 400 hours) have been disassembled because of manufacturing faults, only 16 percent because of faulty operation.

| Location | Wright Pat. (new) | Chrysler (new) | Oklahoma City |
|---|---|---|---|
| No. of engines | 165 | 107 | 88 |
| Average hours | 233 | 192 | 99 |
| Reason for overhaul: | | | |
| Manufacture | 93 | 60 | 36 |
| Operation | 20 | 18 | 19 |
| Maintenance | 25 | 14 | 23 |
| Allowable Operating Time | 16 | 4 | 1 |
| Other | 11 | 11 | 5 |

5. The conclusions indicated in the memorandum on Engine Fires, by the facts of brief B-29 engine life, are not lessened in urgency by these facts, although the average "life" of overhauled engines is a little longer than in the preceding month of September.

W. J. CROZIER
Operations Analyst



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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21 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Precipitation Static in B-29's.

1. Precipitation Static is a serious problem for air-ground communications. It also constitutes a potential accident hazard.

2. The B-29 due to its size, speed and structural details is peculiarly subjected to this form of atmospheric disturbance.

3. A tremendous amount of work directed toward the elimination of this problem has been done by the Joint Army - Navy Precipitation Static Committee, Wright Field and other agencies.

4. Remedy for disturbances, at least to a considerable extent have been found. These are:

a. A new type of static discharger.

b. Installation of electrostatic leaks.

c. Bonding of the airplane.

5. The dischargers and instruction for maintenance are available in quantity. Tech. Orders for installation of the dischargers and static leaks in vulnerable spots have been written but not yet to be issued. Information on bonding and other pertinent point has been collected at various meetings.

6. It will take some time before this information can be disseminated through the usual procedures. It would seem indicated to send out some advance information because it has been gathered from mission reports that the XX Bomber Command has encountered difficulties attributable to precipitation static on combat missions. Accident reports from the theater, from airplanes in transit and from training airplanes of the Second Air Force indicate very definite hazards.

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7. As first step it is suggested that the weekly news letter of the Twentieth Air Force carry an item, about as follows:

a. Considerable effort has been devoted toward the elimination of precipitation static disturbances and hazards to which the B-29 is subjected more than any other now existing airplane. An improved static discharger is now available in quantity. Its designation is AN/ASA-3 (Signal Corps Stock No. 2Z8882-3) and can be ordered through the usual channels. Information on static leaks and bonding will be sent to the Commands by mail. This in conjunction with the new dischargers should greatly reduce the troubles encountered.

8. With respect to the second last sentence of paragraph 7, a decision is desired whether advance copies of technical orders now being prepared for issue and bonding suggestions obtained in various meetings should be sent either to the Commands or the Operations Analysis Sections of the Commands, or if this Division is to prepare a separate memorandum presenting the available information in informal fashion.

H. E. LANDSBERG
Operations Analyst
OAD, Twentieth Air Force

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Basic Ltr of Trans. Hq 73BW Rep. of Acc.

452 '25 Mar) AIMAT 1st Ind. CC:ay
HEADQUARTERS XXI BOMBER COMMAND, APO 234, c/o Postmaster, San Francisco, California, 30 Mar 1945

TO: National Advisory Committee of Aeronautics, Washington, D.C.

Forwarded in compliance with AAF Regulation 60-9 dated 23 May 1942.

FOR THE COMMANDING GENERAL:

1 incl: n/c

REXFORD H. SALISBURY
Major, Air Corps
Actg Ass't Adjutent General

cc CO, ATSC
Wright Field
Dayton, Ohio
ATTN: Chief, Experimental Div.

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HEADQUARTERS
73RD BOMBARDMENT WING
APO #237, c/o POSTMASTER
SAN FRANCISCO, CALIFORNIA

73 BW 452 U

SUBJECT: Letter of Transmittal.

TO: Commanding General, Air Technical Service Command, Wright Field, Dayton, Ohio, THRU XXI Bomber Command.

1. There is transmitted herewith, for your information, a report of an unusual incident which occurred during the flight of a B-29 airplane assigned to this wing.

For the Commanding General:

/s/ W. W. FARQUHAR
Lt. Col., Air Corps
Adjutant.

1 Incl.
Incl 1 - A report of an Airplane Incident

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Statement from Captain William Gifford, 01799094, Airplane Commander, regarding an explosion occurring at 1558Z on 9 March, 1945, altitude 4800 feet speed 201 mph, 34° 08' N - 140° 20' E.

I first saw St. Elmo's Fire at odd times and infrequently 30 minutes prior to the explosion. It acted normally as has been seen many times before. Dismissed as harmless and told crew that it was harmless. Three or four minutes before explosion occurred, St. Elmo's fire seemed to be greatly intensified when suddenly the entire ship-wingtips, prop arcs, aerials, surfaces, and protruding points in my view - were enveloped in sheets of fluid looking fire. The two props on my side (left) became solid mass of whirling flames. The right gunner called in that #3 engine was completely covered in flame and added quickly that "#3 has exploded". The instant that followed, great sheets of flame raced inward from the left wing tip and prop to my window, changing incolor from white to a pinkish hue. Following the contour of the nose and concentrating into a pinkish colored ball of fire around the nose of the A/C. An instant later, a tremendous explosion occurred, both audible and felt. The entire forward compartment of the A/C was brilliantly lit. The force of the explosion and the intense light stunned me for perhaps 30 seconds. The cockpit filled with smoke and had the odor of burning metal. My first conscious thought was that the bombs in the bay had exploded. The first thing actually seen was my co-pilot grouping toward the instrument panel with a flashlight. I yelled to him to put the light on my instrument panel. He then reached over and put the beam on my panel and I quickly saw that the A/C was flying normally except that it was in the process of correcting itself from a steep right bank. I next yelled to the Bombardier to salvo bombs. He answered that he could not see. I opened the bombay doors with toggle switch on pilot's aisle stand and got confirmation that both doors were open from other crew members. By this time the bombardier had sufficiently recovered from his first shock to push the salvo handle for bombs. Bombs went out without trouble and I closed doors with aisle switch. I then ordered the radio operator to examine and treat the bombardier and the radar operator to treat the right gunner who said his eyes and been burned. I then ordered one man in the forward and one in the rear to examine each bombay carefully for fire and other possible damage.

Soon after the explosion occurred and I could orient myself, I turned to a heading to take me away from the Jap coast as we were very close at the time. We flew east for some minutes in order to cross away from the path of following A/C and then took up a course which would return us to out base. Due to the fact that lightning strikes continued to occur and a small amount of St. Elmo's fire continued to play around the props, I had all electrical equipment turned off with the exception of a few fluorescent light.

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The weather which seemed to induce the occurrence was accompanied by severe turbulence, heavy rain and hail or sleet and dense black clouds. After turning on course to return to base and as the weather condition gradually lessened, we began to experimentally turn on essential electrical equipment. Gradually all necessary electrical equipment was turned on with no further ill effects. All such equipment worked properly with the exception of the Collins transmitter. (Blown tubes) (The trailing antenna was out at the time of the explosion).

After 1/2 hour of examination and observation, the only apparent damage to the A/C was the bombardier's nose shield. One glass panel was punctured with a hole about 3 inches in diameter. The fram was twisted and one other panel was severely cracked. Fine particles of powdered glass and mica covered the aisle stand, floor and various objects in the cockpit. Upon landing several static eliminators were found burned off.

I have seen St. Elmo's fire on many occasions and on 2 previous occasions the A/C which I was flying was hit by lighting. I have never known or heard of St. Elmo's fire being dangerous to an A/C and on the 2 previous occasions when the A/C in which I was flying was hit by lightning, there was no indication except that a streak of lighning had whizzed past near the fuselage, with only minor damage to radio equipment. The envelopment of an A/C in sheets of fire and subsequent explosions is the first knowledge I have ever had that an A/C in flight may be severely damaged or destroyed by lightning. It is possible that if we had had bombbay tanks aboard, the A/C would have been completely destroyed by the flash explosion.

the hole in the nose windshield is at the place where the free air temperature gauge is installed. It is possible that this instrument is improperly bonded and therefore was unable to throw off a super charge of static electricity. However, it must be borne in mind that the explosion and brilliant flash was as intense in each compartment of the A/C as it was in the nose.

Statement from Major Julius F. Farris, 022230, co-pilot, regarding an explosion occurring at 1558Z on 9 March 1945 altitude 4800 ft, speed 201 mph, position 34° 08' N - 140° E.

The first unusual thing noticed by Major Farris was an intense display of St. Elmo's fire. A static discharge was noticed coming from the nose section which blinded Major Farris for approximately 30 seconds. A loud explosion occurred about 4 minutes after the intense St. Elmo's fire. This was followed by intense smoke filling the cabin. The explosion threw the plane

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ing an unusual position with the right wing way down. Normal position was recovered soon after. Bombs were jettisoned and plane searched for fire but none were found.

Statement from 2nd Lt. James C. Harris Jr., 0695420, navigator, regarding an explosion occurring at 1558Z on 9 March 1945, altitude 4800 ft, speed 201 mph position 34° 08' N - 140° 20' E.

Just before the explosion, Lt. Harris asked Sgt. Hale, the radio operator, to bring in the trailing antenna. As he was pulling it in a large arc of blue flame jumped across the antenna throw switch, followed immediately by a loud explosion. There seemed to be a lot of smoke and dust in the air with an odor of gun powder prevailing. Lt. Harris was not shocked or blinded by the explosion.

Statement from 2nd Lt. Charles B. Hollis III, 0866702, Flight Engineer, regarding an explosion occurring at 1558Z on 9 March 1945, altitude 4800 feet, speed 201 mph, position 34° 08' N - 140° 20' E.

St. Elmo's fire was noticed on #3 and #4 prop tips and leading edge of the wing. Just a few seconds before the explosion, the St. Elmo's fire built up to a considerable extent, covering the entire prop of #3 Engine, with long streamers of lightning like sparks going forward from the prop. While the sparks were building up in intensity, a blinding flash and explosion occurred. This was immediately followed by black smoke with a gun powder like odor. The flash blinded Lt. Hollis for about 30 seconds. His sight then returned to normal.

Statement from Sgt. Donald E. Hale, 39272260, radio operator, regarding an explosion occurring at 1558Z on 9 March 1945, altitude 4800 feet, speed 201 mph, position 34° 08' N - 140° 20' E.

I first saw arcing on antenna switch immediately after the explosion. The compartment was filled with smoke, I then turned off the equipment on orders. I gave the bombardier first aid, I put sulfa powder on wounds, gave him morphine, and dressed the wounds. I gave him sulfa pills. He was slightly in a state of shock. He went back into the CFC compartment and laid down.



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Statement from Sgt. Alfred T. Roberts, 18217118, Radar Operator, regarding an explosion occurring at 1558Z on 9 March 1945, altitude 4800 feet, speed 201 mph, position 34° 08' N - 140° 20' E.

I could see very little from my position. I saw a glow on the right wing through a crack. Just before the explosion the glow on the wing got very bright. I put my hands over my eyes as explosion occurred. The ship filled with smoke and I thought we were hit. All others were blinded and I had my hands over my eyes so was unaffected.

I went forward to the CFU cabin to aid S/Sgt. Nelson after hearing check of personnel on the intercom by Capt. Gifford. I used boric salve on his eyes and covered them with eye pads and laid him down in the radar room and hung his head back over his jacket and covered him up and gave him two aspirins for his headache. I then repeated the treatment for Sgt. Kirconner and gave both water. When Lt. Kennedy came back I made him comfortable and fixed a place for him to lie down. It took about 2 minutes for that smoke to clear.

Statement from Sgt. Andrew A. Sebby Jr., 36747055, Tail Gunner, regarding an explosion occurring at 1558Z on 9 March 1945, altitude 4800 feet, speed 201 mph, position 34°08' N - 140° 20' E.

I noticed trailing antenna appeared to be painted fluorescent. Static eliminators of the stabilizers were throwing off fire. I looked out the right side when the explosion occurred and was blinded for about 10 minutes. I asked what happened on the interphone but don't remember the answer. It looked like the whole ship was on fire. The guns had fire coming off as on the static eliminators. I am not sure whether smoke was in the tail section. I could not see flashlight during time of blindness. I took off armor plate door on instructions.

Statement from S/Sgt. Lester S. Nelson, 39[illegible]826[illegible], CFC Gunner, regarding one explosion occurring at 1558Z 9 March 1945, altitude 4800 feet, speed 201 mph position 34°08' N - 140° 20' E.

S/Sgt. Nelson was in the right gunner's position at the time of the explosion. His first observation of anything unusual was that the t trailing edge of the right wing was glowing. This kept up for about five minutes. The fixed

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antenna also seemed to be glowing; The glow, after about five minutes, left the wing and antenna and gathered under the #3 nacelle and became much brighter. After several seconds an explosion occurred which was both audible and visible. It seemed as though the entire right wing was white hot. There was dense dark smoke in the CFC compartment. S/Sgt. Nelson was partially blinded by the flash of the explosion but after treatment with boric acid and pads on his eyes he regained normal sight.

Statement from Sgt. Albert DeGenner, 19177616, Left Gunner, regarding an explosion occurring at 1558Z on 9 March 1945, altitude 4500 feet, speed 201mph, position 34° 6' N - 140°

I saw glow on trailing edge of the wing and reported it to Capt. Gifford. Immediately after there was an explosion. I was blinded for a few minutes. The inside of the cabin filled with smoke. My first impression was that the bombs in the bay had gone off. I could not assist in first aid because I was blinded myself for approximately 10 minutes.

Statement from Sgt. James B. Kirchner, 35692810, Right Gunner, regarding an explosion occurring at 1559Z on 9 March 1945, altitude 4800 feet, speed 201 mph, position 34°08' N - 140°

Sgt. Kirchner was sitting in the doorway between the radar and CFC compartments when he saw a large bluish flash coming from the right wing. This was followed immediately by a loud explosion. Smoke filled the compartment. The smoke had an odor that resembled gun powder. The explosion temporarily stunned Sgt. Kirchner and he was treated for burns around the eyes. His sight seems normal now.

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9 April 1945

MEMORANDUM FOR MR. JOSEPH WEICHBROD, M. & S., ROOM 5D-863.

Subject: Accident Due to Static Electric Discharges.

1. On 20 January 1945 a B17-G, piloted by Lt. W. K. Finney on a weather reconnaissance flight out of Kindley Field, B. W. I., ran into severe atmospheric electric disturbances causing damage to the aircraft. This airplane is attached to experimental Electronic Squadron.

2. From the flight log the following data are quoted:

"Between 0400 to 0430 Z the aircraft was in a zone of severe lightning at latitudes 31° 50' N, longitude 78° 15', to Latitude 32° 30' N, longitude 77° 17 ' W. There was at 0400 heavy turbulence, very severe lightning all around plane cloud to cloud, also discharges from top of clouds into clear sky. St. Elmo's fire all over plane. At 0415 lightning struck a/c, two very sharp reports. Crew was O.K., but tore off trailing wire antenna, burned holes in the wing and in the elevator Lightning was all through inside of the plane."

HEL:evd

HELMUT E. LANDSBERG,
Operations Analyst,
OAD, Twentieth Air Force.

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Dr. Landsberg/rab/4819

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19 April 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Development of Equipment by General Electric Company for Weather Reconnaissance and Precipitation Static.

1. Upon the suggestion of Mr. Bennett, Operations Analyst of the Second Air Force, Messrs. Alexander and Horse of the Electronics Division of the General Electric Company at Schenectady, New York, visited me on 19 April 1945.

2. These two gentlemen had spent the preceding day at the Meteorological Laboratory of the University of Chicago. We discussed the following subjects:

a. Precipitation Static equipment developed by Professor Dana.

b. Dropable Radio-Sondes

c. Dew Point Recorder

d. Coupled Pressure and Radio Altimeter

3. I was told that General Electric Company will furnish Professor Dana with the necessary equipment to test his idea on the elimination of precipitation static by the block and squirter method. Mr. Alexander repeated Dr. Langmuir's statement that he thinks this is the best method as yet proposed to eliminate the troubles encountered. In view of the possible Post War Aviation developments, they are willing to spend considerable effort to help Professor Dana to develop his idea to perfection.

4. General Electric Company has also developed a radio-sonde and light-weight airborne recorder which will take 88 readings a minute. This type of equipment can be dropped at a very high rate of speed and still give the desired information. They presented this development some time ago to the Signal Corps, but found practically no interest in the development. They expressed their disgust with the attitude shown by the Signal Corps people. They then offered this development to the U. S. Navy and I was told that the Navy got interested and has started a limited procurement of several hundred of these radio-sondes and a prototype of the recorder. No drop tests have been performed by General Electric Company to this moment. I suggested that they should immediately make some flight tests and

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they expressed the opinion that they can do these in cooperation with the Navy.

5. We then discussed the problem of the dew point recorder developed at the University of Chicago. Major Fletcher who is in charge of the development work for weather reconnaissance equipment for the Air Liaison Officer with the Signal Corps. expressed to me recently after returning from a tour of duty in the Pacific the idea that "None of our present equipment for measuring humidities is satisfactory". Mr. Horse of General Electric stated that the equipment developed by the University of Chicago is the most promising new development along this line. They are going to negotiate with the University to obtain development rights on the apparatus and assured me that within a short period of time, test models can be secured. If sufficient pressure is brought to bear, such equipment could be constructed on a production basis in sufficient quantity within three to six months.

6. The discussion of the ideas mentioned in paragraphs 4 and 5 was carried on in the presence of Major Paul Davis, Weather Officer for Reconnaissance Branch of OC&R. He was very much interested in both and informally suggested that tests at the AAF Board in Orlando of these two pieces of equipment be performed as soon as practicable. The following procedure was suggested: General Electric would send to us a report on the development of these ideas and we would forward them to OC&R Reconnaissance officially and suggest to them that Board tests be performed. Major Davis will then set the necessary machinery into action through his Division.

7. Finally, I outlined to Messrs. Alexander and Horse the desirability of having a combined radio and pressure altimeter. This is to read directly the difference between pressure altitude and absolute altitude. The availability of such equipment would greatly facilitate the use of the D-Method of navigation, probably improve the accuracy of drift determinations and eliminate the necessity for certain rather tedious procedures now necessary to obtain the desired results. They will within a short period of time submit to us a report of whether this is technically feasible. It can then be decided what development along this line should be attempted.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

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26 April 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE.

Subject: Lightning Strike on B-29.

1. Your attention is called to the very complete and excellent report on the lightning strike that affected a B-29 on the mission of 9 March 1945 about which you had given us some preliminary information. This report was obtained from Colonel Aldrin's office at Wright Field.

2. This matter was called to attention of Mr. Weichbrod in AC/AS, M & S.

3. Particularly noted should be the following points:

a. Damage occurred on nose of ship where free air thermometer is installed. This piece of equipment was probably not properly bonded.

b. Sparks were noted at antenna transfer switch. Probably no grounding resistance was installed on this equipment in the particular aircraft.

c. Trailing wire antenna was not reeled in when St. Elmo's fires were encountered.

4. Attention to all these points had been called in the undersigned's memorandum to the Chief of Staff of the Twentieth Air Force, dated 22 December 1944. As a result of this memorandum a letter was prepared in this office and sent to the Commanding General XXI Bomber Command over the signature of Colonel Fisher. Paragraph 3a (1) of this letter called attention tot the Technical Order covering elimination of internal sparking by installing grounding resistance. A copy of the Technical Order was attached to Colonel Fisher's letter. Paragraph 3a(2) of the letter suggested the retraction of the trailing wire antenna in all thunderstorm areas. Paragr ph 4 called attention to the bonding problem.

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5. It is felt that in view of the potential danger of lightning strikes and internal sparking in case of the presence of gasoline fumes, attention of the field commands should again be called to these points and that proper remedial action be taken, as well as personnel be familiarized with best procedures to minimize the troubles.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

1 Incl:
Statements by
Crew Members

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CST/H.E.LANDSBERG/rab/4819

5 June 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Accident Possible Due to Precipitation Static.

1. From cable received from the theater the following information is quoted:

"B-29 taking off from Guam, North Field, crashed into ocean. Large flash of light seen from runway lasting about one minute. Happened in air, fell into water. Weather at the time, low clouds; base, 1,000 feet; visibility, eight miles; winds from East, six miles per hour; some lightning."

2. This is another one of the "unexplained" accidents. Evidently, the aircraft was flying directly under a thunderstorm. It is known that immediately below the clouds the static electric field is strongest and it is well to consider the hypothesis that lightning or a static electric discharge could have caused the accident.

3. The sequence of events that could lead to such an accident would be as follows:

If an improperly bonded aircraft flies into a strong electric field a lightning discharge might get into the aircraft. This has happened in the past on several occasions. It is also possible that internal spark discharge may take place. If such a discharge finds gasoline fumes in the aircraft, an explosion may well occur.

4. If this hypothesis is accepted, the seriousness of atmospheric static finds a new emphasis and remedies ought to be sought for at the earliest possible moment. The cost involved in losing only a single B-29 with the accompanying loss of life would warrant large expenditures to solve this problem. Our only avenue of approach promising success at this moment is Dr. Dana's "block and squirter", and every effort should be made to bring it to the test stage where its efficiency could be investigated.

HELMUT E. LANDSBERG
Operations Analyst

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CST/Dr. Landsberg/ma/72993

13 June 1945

SUBJECT: Elimination of Precipitation Static

TO: Commanding General
Air Technical Service Command
Wright Field
Dayton, Ohio

Attention: Colonel B. E. Aldrin,
Engineering Division, Flying Aids Branch

1. Precipitation Static has caused considerable difficulties with communications on B-29 combat missions. A few pertinent quotations are given from mission reports of the XX Bomber Command. There are also several cases on record where serious accidents have been directly or indirectly caused by Precipitation Static.

2. This headquarters is very much interested in all developmentsleading to the elimination of this hazard to flying. We are particularly anxious to have the equipment designed by Dr. Homer Dana, Operations Analyst, of Headquarters, Second Air Force, tested. It is our understanding that General Electric Company, Schenectady, New York, is in the process of building a test unit according to Dr. Dana's designs.

3. In view of the operational problems involved, any support that you may give in aiding developments along this line will be of distinct help.

For the Commanding General:

1 Incl:
List of Cases of
Static Interference

LAURIS NORSTAD
Brigadier General, U. S. Army
Chief of Staff

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CASES OF STATIC INTERFERENCE WITH GROUND TO AIR COMMUNICATIONS OF XX BOMBER COMMAND MISSIONS

| | |
|---|---|
| Mission 4 | Interference due to local storms was encountered |
| 5 | Static caused interference and storms occasionally cut off communications entirely |
| 6 | Considerable difficulty was experienced in receiving transmissions due to unfavorable climatic conditions |
| 7 | Atmospheric conditions were such that radio transmission was seriously hampered |
| 9 | Natural interference was logged as being quite heavy |
| 12 | Weather conditions affected air-ground communications to a large extent, operators logging static at a W-5 level |
| 13 | Atmospheric interference was again reported as being heavy |
| 14 | Weather static was encountered |
| 16 | A high static level due to inclement weather hampered reception |
| 17 | Once again a high noise level was encountered |
| 19 | A high noise level was encountered on all frequencies which can be attributed to the bad weather encountered on the way to and return from the target |
| 22 | The usual amount of heavy atmospherics was encountered |
| 23 | Heavy atmospherics were reported when aircraft were flying in bad weather conditions. |
| 27 | Strong atmospheric interference was present on all frequencies during a large portion of the mission |
| 33 | From 0030 - 0500 GMT when flying through weather disturbances the static level rose appreciably; in some cases being reported as being at W-5 level |
| 37 | High static levels were experienced as the aircraft flew through storms |
| 42 | Heavy static was encountered when the aircraft flew through storm areas. |

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of
The Commanding General
Army Air Forces
26 Jan 45 RLS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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26 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH, AF.

Subject: Report and Recommendations concerning Defrosting, Deicing and Interior Heating of B-29 Aircraft

1. Since this Division was first requested, on 12 October '44, to undertake and monitor the problems of Defrosting, Deicing and Interior Heating, the following events have transpired:

a. Frosting.

1. Kits have been designed, manufactured and sent to the Theater in sufficient quantities to service all aircraft not otherwise equipped with adequate defrosting devices. Recent advice, as of 20 January '45, from XX Bomber Command, indicates that they have not yet been received, but M & S assures us they have been shipped.

2. Tests of the kits, conducted by Boeing, indicate that they are inadequate to clear frost from windows 9 and 7. Steps have already been taken to modify the kits and to correct this deficiency.

3. Boeing has been directed, by message dated 11 December '44 to provide adequate cabin heating and defrosting for all portions of the plane, including the tail gunner's compartment.

4. It thus appears that adequate steps have been taken to correct the frost situation.

b. Icing. Current reports from the XX and XXI Bomber Commands indicate the evidence of external icing on windows so as to interfere with visibility.

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1. Mr. Paul Scherer of N.D.R.C. is now engaged with Boeing at the laboratories of the University of California in testing a proposed method of transferring heat between the panes of glass in the bombardier's compartment and in the tail gunner's compartment in sufficient quantities to remove not only internal frost but external ice. If and when a feasible method has been evolved, it will be coordinated closely with AC/AS M & S.

2. The problem of other icing difficulties on the exterior of the glass portions of the nose compartment is one of major structural design and if research is necessary to ship the modifications needed, we are informed by N.D.R.C. as it is a long term project and not within the present endeavors of N.D.R.C.

3. Other problems of icing affecting the flying characteristics of the airplane are receiving the attention of Major Swain of the Office of Flying Safety. An R & R, dated 24 Jan '45 from O.F.S. to M & S properly requests a systematic program of icing tests and adequate flying procedures based thereon.

c. Interior Heating.

1. Mr. Scherer has completed a report on the heating of tail gunner's compartment under date of 22 Dec '44. This was forwarded to your office as received.

2. Recommendations.

The temptation is great, as warmer weather comes on, to relax our endeavors on these subjects when their immediacy is removed. Unless they are relentlessly pursued, we will again lose men and aircraft and impair our operations next winter. Accordingly, it is recommended that priority studies and tests be continued on the following:

a. Interior heating of all occupied portions of the airplane

b. De-humidification of the occupied portions to reduce humidity and hence frost. We are informed that silica-jell containers have been tried but have been found too heavy. Other means have been suggested which may prove feasible, such as Frigidaire units to operate alternately; one (or more) collecting frost while the other (or others) are being defrosted, reducing the moisture to water form permitting it to be drained off.

c. New lighter and less absorbent insulating material. The present material is kapoc and milkweed fibre, which absorbs approximately 30% of its weight in moisture while standing on the ground in humid



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climates. The moisture thus absorbed unnecessarily increases the humidity in the cabin portions under pressure. It is suggested that a lighter and less absorbent insulating material could be used such as the XAA-FF (preformed) Insulation manufactured by the Owens-Corning Fibre Glass Company. Sample attached. This may not be the best device but the idea seems to be sound, as this material absorbs only 1/10 of 1% of its weight in moisture.

d. An adequate method of deicing nose surfaces. It has been suggested that the air foil of the B-29 would permit the discharge of exhaust heat at certain places in the nose from whence it would flow as a laminated hot or warm air layer over all glass surfaces. Such a suggestion should at least be studied to determine its feasibility.

e. An adequate method of deicing wing surfaces. Experience indicates that ice forms on the bottom surface of the wing aft of the deicer boot surface. There seems to be no present method of combating this condition.

f. An adequate method of deicing propellers. A non-inflammable deicing fluid has been suggested which, by some internal control, might be forced on to the propeller surfaces.

3. Conclusion.

The foregoing ideas indicate the type of groping toward solutions of baffling problems. They are here recorded merely to preserve them and allow them to be passed on to some effective agency. No doubt many have been tried and discarded. Certainly others will evolve as the problem obtains the serious consideration it deserves.

Coordination:

AC/AS, O.C. & R.
M. & S.
O.F.S.

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

P.S. Since the preparation of the attached Report, two items have come to our attention which should be added thereto by way of supplement:

M & S informs us that by Change 674 of the Boeing Aircraft Company a refinement of the principles embodied in the Defrosting Kits has been made a structural change in the planes, so as to accomplish a consistent defrosting without the use of the kit devices. Indication from the field points to the fact that these modifications are effective.



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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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The Commanding General
Army Air Forces
29 NOV 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

29 November 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Fuel Consumption.

1. Some weeks ago this office was requested to examine the problems involved in increasing bomb loads on VHB operations by economizing fuel consumption. Accordingly, the following men were detailed to investigate this problem:

Mr. Joseph Kuzman, Engineer.
Dr. Edwin Hewitt, Mathematician.
1st Lt. Robert Bratt, AC, on TD from Wright Field.

Dr. Hewitt and Lt. Bratt participated in a detailed study, including flight testing, of fuel consumption of B-17's in the Eighth Air Force. Preliminary study has been made of the Tactical Mission Reports, together with additional information obtained directly from the XX Bomber Command, as well as experimental data obtained from Wright Field.

2. The XX Bomber Command seems to be well on top of this problem. The Operations, Plans and Training Section of that Command has prepared a Flight Engineers Manual outlining procedures for obtaining maximum efficiency in the fuel consumption of B-29 aircraft in long range bombardment operations. This document, which also contains instructions for emergency procedures, appears to follow closely the best known techniques developed experimentally in this country, with adjustments as necessary for the particularities of operations from China bases.

3. If the procedures given in this manual are followed, in Hq. in prescribing the flight plan and in predicting average fuel consumption, and by the individual crews during the mission itself, it can be expected that a high degree of efficiency in fuel utilization will be obtained.

4. However, a wide variation in the amount of fuel consumed is being reported by individual aircraft on the same mission (the range between the maximum and the minimum consumption on missions to Kyushu has averaged 1200 gallons). This variation may be attributed to:

a. Crews failing to follow the procedure outlined in the Flight Engineers Manual.

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b. Difference among aircraft (carburetor settings, characteristics of the engines, weight of the aircraft, etc.)

c. Factors which prevent the recommended procedures from being followed or involve slightly different flight plans for individual aircraft, (formation flying, malfunctions of equipment, battle damage, etc.).

5. Accordingly, measures to minimize the average fuel consumption, and to reduce the variations among individual aircraft involve the following:

a. Insuring the fullest training of B-29 personnel in the principles of fuel economy on long range missions as described in the attached manual.

b. Making continued analysis of the operational performance of individual aircraft and crews.

6. Captain Louis H. Sibilisky, formerly of Wright Field, has been in the CBI Theater, for a number of months, working on fuel consumption problems with the XX Bomber Command. We are informed that he will return to Wright Field within the next ten days.

RECOMMENDATIONS:

I That the FEM attached be made available to XXI Bomber Command and Second Air Force for their information and training.

II That Captain Sibilisky be brought to Washington to report on current developments in this field in the XX Bomber Command, and that the possibility be explored of having him assist in the Flight Engineer Training Program.

III That, since the detailed data for study of individual a/c and crew performance is available only in the combat theaters, analysis of this problem be conducted in the field rather than at Washington Hq. Attention is called to the fact that H. W. Berger is presently attached to the XX Bomber Command and F. Fennema is attached to OAS, XXI Bomber Command, for this purpose.

DR. EDWIN HEWITT
Operations Analyst

JOSEPH A. KUZMAN
Operations Analyst

APPROVED BY:

ROBERT BRATT
1st Lt., AC.

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of The Commanding General Army Air Forces
5 Jan 45 RAS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

5 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Preliminary Analysis of Fuel Consumption and Bomb Loads on B-29 Missions No. 1 to and Including No. 15 XX Bomber Command.

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I. Prefacing Remarks

1. Fuel consumption and the determination of maximum bomb loads in very long range B-29 operations is an inherently complex problem and can only be studied effectively in the field by consideration of the performance data of individual aircraft. It cannot be too strongly emphasized that a preliminary analysis based on overall average data taken from Tactical Mission Reports, such as this is, can achieve nothing more than an objective presentation of accomplished facts. An attempt at qualitative comparison of one mission with another, without a proper weighting of the myriad factors influencing the operations, would result in erroneous and dangerous conclusions.

II. Limitations of Overall Analysis

1. Analysis is limited because of the varying conditions under which each mission is carried out and because of the wide variation in the performance of individual aircraft.

a. Differences between maximum and minimum fuel consumed, for aircraft flying the same mission, average around 1200 gallons or approximately 7200 lbs of fuel. The reasons for this variation are manifold and cannot be segregated when overall average figures are used.

b. Differences between missions, assuming a constant take-off gross weight, arise because of:

(1) Variation in briefed flight plans

(2) Type of formation flown

(3) Time of mission i. e. daylight or night

(4) Weather conditions

(5) Enemy opposition encountered





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(6) Take-off base

c. Variations in performance of individual aircraft are attributed to:

(1) Degree of experience and ability of crews

(2) Flight plans of individual aircraft

(a) Position in formation

(b) Time of take-off

(3) Navigational errors

(4) Differences in aircraft

(a) Basic weight and fuel capacity

(b) Inherent differences in speed and fuel consumption characteristics

(c) Condition of aircraft

(d) Degree of cowl flap opening required for cooling

III. Accuracy and Treatment of Data

a. Fuel consumption data as given is reported to be accurate within 200 gallons. Limitations of present fuel measuring equipment and the limited time and personnel available in the forward area after missions prevent greater accuracy.

b. Data on fuel consumed and fuel remaining as compiled by the Operations, Plans and Training Section differs in some cases as much as 100 gallons, from that compiled by the Statistical Section for the same mission. Although the disparity is due to the inclusion of different numbers of aircraft by each section it nevertheless adds another inaccuracy in the evaluation of overall data. A simple average of the conflicting values was used in compiling the charts and tables in the appendix.

c. "Air miles flown" are difficult to determine with accuracy. The fact that the reported figures may be in error must be considered.

IV. Missions Nos. 1-15 As A Whole for Aircraft Bombing Primary Targets

a. Of the fifteen missions flown; eleven were staged from Chengtu bases, three from India bases and one from China Bay. Of these; eleven were daylight missions and four, plus a portion of Mission No. 7, were night missions.

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b. On the eight daylight missions staged from Chengtu:

(1) Average gallons of fuel consumed per air mile flown ranged from 2.09 to 1.38.

(2) Average air miles flown ranged from 2520 to 3370 miles.

(3) Average bomb loads carried per plane varied from 3160 lbs to 13560 lbs.

c. On the three night missions staged from Chengtu for which figures are available:

(1) Average gallons of fuel consumed per air mile flown ranged from 1.95 to 1.88.

(2) Average air miles flown ranged from 3262 to 3375 miles.

(3) Average bomb loads carried per plane varied from 3160 lbs to 5860 lbs.

d. The three missions staged from India bases were daylight missions. On the two missions for which figures are available:

(1) Average gallons of fuel consumed per air mile flown were 2.33 for 1750 miles and 1.86 for 3870 miles.

(2) Average bomb loads carried per plane were 20800 lbs and 3250 lbs respectively.

e. For the one night mission from China Bay:

(1) Average gallons of fuel consumed per air mile flown were 1.80 for 3855 miles.

(2) Average bomb loads carried per plane were 2010 lbs.

f. Average take-off gross weights ranged from 130900 lbs to 133400 lbs.

g. Differences between maximum and minimum gallons of fuel consumed per mission ranged from 820 to as much as 1850 gallons for aircraft flying the same mission. The later missions (Nos 9-15) averaged around 1200 gallons.

h. Average gallons of burnable fuel remaining after missions ranged from 654 to 1244 gallons. The later missions (Nos 10-15) averaged below 1000 gallons.

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V. Discussion

a. The major point of importance brought out by this preliminary analysis is the need for an intensive field study of the reasons for the large difference, of approximately 1200 gallons, which exists in the amount of fuel consumed by aircraft flying the same mission. It is apparent that an improvement in this one item would directly increase the bomb carrying capacity of the B-29.

b. This wide variation in performance is attributable to the various reasons indicated in paragraph 2 (c). In order to segregate and analyze these reasons satisfactorily it is necessary to have an accurate field record of the fuel consumption characteristics of each aircraft under various conditions of flight.

c. The present fuel measuring equipment on the B-29 affords only a rough indication of fuel consumption characteristics and does not permit of any accurate comparison of individual aircraft performance with the average or representative chart performance.

d. The XX Bomber Command is fully cognizant of the individuality of each aircraft and flight crew. Field records are being rigorously maintained insofar as possible with present limited equipment and every effort is being made to fit the bomb load to the capabilities of each crew and aircraft.

VI. Conclusion

1. Installation of fuel flow meters on B-29 aircraft, to determine and record fuel consumption more accurately, is a prime necessity for the proper determination of maximum bomb carrying capacity.

JOSEPH A. KUZMAN
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

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5 Jan 45 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

5 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Vital Need for Accurate Fuel Metering Equipment in All B-29 Aircraft

1. It is realized that fuel flow meters and totalizer fuel gages are under consideration for installation in B-29 aircraft. A memorandum from the Boeing Aircraft Representative detailing the present status of the projects is attached. However, the extreme value of this equipment in providing information for determining bomb loads to be carried by individual aircraft and in reducing the number of abortives due to gas shortage makes it imperative that all possible pressure be brought to bear to hasten production and installation of the units.

2. Fuel quantity gages now in the B-29 aircraft are reported as reasonably accurate only below 400 gallons and are of little value in determining actual fuel consumption during flight.

3. The flight engineer must depend on the published chart for the rate at which his engines are using fuel. He is never certain at any time just how much fuel he has remaining in each tank and therefore does not know the rate at which he must transfer fuel between tanks to keep his four engines running.

4. Differences between individual aircraft, even assuming strict adherence to recommended power settings, cause a wide enough variation in actual, as against average or chart, fuel consumption to mean the difference between carrying too small a bomb load on the one hand or loss of the aircraft because of gas shortage on the other.

5. Installation of fuel flow meters would provide an accurate check of the actual fuel consumption of each engine for various legs of the mission. It would not only serve as an aid to efficient cruise control but would also provide valuable overall performance data for planning future missions. Wholly as important is the fact that it would act as a constant indicator of individual engine performance, particularly in checking carburetor settings, and would be invaluable to the flight engineer in warning him of malfunctions.

6. Installation of totalizer fuel gages would provide an accurate means of determining fuel remaining in each tank. Together with fuel flow meters they would provide the flight engineer with the vital information necessary for safe and efficient operation of this huge and complex power plant.

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7. One-hundred-eighty (180) fuel flow meter units Type B-3, available from stock at Wright Field have been allocated; 30 units to each of six Wings (Weekly News Letter, 23 December 1944, Par. II, 1). Equipment will be provided in kit form for field installation at overseas stations.

8. Production units of fuel flow meters Type B-3A, as estimated by Wright Field will be available within five to six months. This is more pessimistic than the Boeing estimate of approximately three months. No installation in field or service aircraft has been as yet contemplated.

9. It is strongly recommended that a first priority be assigned to the project of fuel flow meters and totalizer fuel gages, and that every possible effort be made to increase the rate of production and installation of the units.

JOSEPH A. KUZMAN,
Operations Analyst.

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

4 April 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Suggestion for Possibility of Increased Gasoline Economy in B-29 Operational Flight

1. In studying the reports of the various bombing missions of both the XX and XXI Bomber Commands, it was noted that it is ordinarily the practice after take-off to fly at a continuous altitude until a change is desired and then to shift to a steep ascent at the maximum climb permissible with rated power being developed by the engines. In some cases the total elevation desired at the destination of the flight may be obtained by a repetition of this procedure to produce a series of steps in the vertical flight profile.

2. It would appear from a study of the fundamental characteristics of gasoline engines and fuel consumption at various percentages of rated maximum power that such a type of vertical flight pattern is not the most economical and that material economies could be affected by either flying a vertical course which allowed a uniform ascent between take-off and destination or perhaps even preferably a curved ascent pattern in which the rate of ascent increased proportionally to the distance from point of take-off. It is interesting to note that in a recent analysis of flight procedures possible with stripped B-29's, made by George Schairer of the Boeing Engineering Staff, it is pointed out that this type of continuous ascent vertical flight pattern would on the average mission result in a gasoline saving between 100 and 200 gallons and a time saving of at least one-half hour.

3. It is recognized that there may be idiosyncrasies in the engine performance or the flight characteristics of the B-29's which may limit to a certain degree the extent to which this vertical pattern may be used and hence the gasoline economies that can be effected. However, if they could have been effected it would have increased the bomb load carried by the Twentieth Air Force on its raids against Singapore by perhaps 25%.

4. Similarly, there has been a less pronounced tendency to fly a stepped vertical flight course on the return from objectives. Again a study of the fundamental characteristics of gasoline consumption of internal combustion engines would indicate that material economies could be effected by flying either a descent pattern of a fixed rate or preferably a curved or continuously varying descent rate.

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5. Mr. George Schairer in his report on the flight characteristics of stripped B-29's states the continuous descent procedure in this case was uneconomical because the power requirements were so low that the necessary waste gate sittings caused low fuel economy.

6. It would appear from a preliminary analysis of the curves for the actual horse power required to flya B-29 with either 3 or 4 engines operating and from a study of the specific fuel consumption of the engines for various power settings, that substantial gasoline economies could be effected in the case of a continual descending flight by shutting down one engine and feathering its propeller so that the other engines could be operated at a load where the SFC is the near the minimum with the carburetors set for the auto-lean condition.

7. While it is realized that there may be many practical difficulties which may preclude the operation of the engines under conditions which theoretically should give maximum fuel economy. The economy which preliminary studies indicate might be effected, are of sufficient magnitude to merit a careful investigation of this type of operation, both on the approach to the objective and perhaps even more on the return. It is also recognized that this type of operation cannot be easily computed from the existing fuel consumption flight charge now available to the aircrews. However, if the indicated economies do exist, it would not be difficult to provide new charts for covering this condition of operation for use by the air crews.

GLENN D. GILLETT
Operations Analyst
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

3 April 1945

MEMORANDUM TO DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE, AND MR. GLENN D. GILLETT, OPERATIONS ANALYST

Subject: Comments on Memorandum on Increased Gasoline Economy in B-29 Operational Flights

1. At the request of Dr. Stearns and yourself, the following comments are made of your memorandum on increased gasoline economy in B-29 operational flights.

a. Moderate altitudes are initially flown by XX and XXI Bomber Commands operating B-29 and B-29A airplanes on first leg of a mission flight due to high gross weight take-offs (135,000 to 138,000 lbs.) which require engine powersettings sufficiently high (to maintain recommended I.A.S.) to necessitate use of auto-rich mixture. That is, cruising climb power setting in auto-lean mixture cannot be used at these gross weights and climb airplane at efficient I.A.S.

After initial leg is flown long enough to reduce gross weight sufficiently to permit engine power settings in auto-lean mixtures for a climbing attitude, an economical cruising climb could be started, at this stage of the flight the distance from the target might be a determining factor for rate of climb and consequent engine power setting.

Mr. Schairer's department analysis, contained in Document D-6848 on B-29B airplane operations where in the airplane performs the initial leg of an assimulated mission flight with a cruising climb, maximum auto lean power setting, at long range cruising airspeeds is only possible on the B-29B airplane due to its reduced drageand is not applicable to the B-29 or B-29A airplane.

b. It is not believed that it would be practical to feather one engine for fuel economy during a descent from altitude.

With the hydromatic propeller, oil would congeal in the dome which may prevent unfeathering for level flight after the descent.

It is further believed that starting a cold engine wherein oil has congealed might very easily lead to engine failure fr m the following reasons:

(1) Lack of lubrication.

(2) Liquid locks.



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(3) Frozen condensate.

(4) Too rapid heating from cold condition.

c. At present time, Mr. Wells' chief engineer, Mr. Merrell, Chief Test Pilot, and Mr. Alexander, Aerodynamist of Boeing Airplane Company, accompanied by Wright Engine Engineers, are using an instrumented B-29A airplane in a combat theater to determine the most efficient operation of B-29 airplanes flying under combat conditions.

2. I have found your paper most interesting and the comments I have made should only be construed as my personal observations based upon my experience with the B-29 airplanes. I would appreciate having a copy of your memorandum for presentation to Boeing for their official comments.

MARVIN P. HOOKER
Boeing Factory Representative

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(4) Too rapid heating from cold condition.

c. At present time, Mr. Wells' chief engineer, Mr. Merrell, Chief Test Pilot, and Mr. Alexander, Aerodynamist of Boeing Airplane Company, accompanied by Wright Engine Engineers, are using an instrumented B-29A airplane in a combat theater to determine the most efficient operation of B-29 airplanes flying under combat conditions.

2. I have found your paper most interesting and the comments I have made should only be construed as my personal observations based upon my experience with the B-29 airplanes. I would appreciate having a copy of your memorandum for presentation to Boeing for their official comments.

MARVIN P. HOOKER
Boeing Factory Representative

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27 March 45
MH/ma/4619

MEMORANDUM FOR : DR. ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

Subject : New Design Instructions for B-29 Airplanes

1. Recent field reports have indicated that airplanes are being delivered to combat theators (XX and XXI Bomber Commands) with new designs incorporated in the B-29 airplanes without information or instructions for the operation and maintenance of these newly designed systems.

2. As a result, improper operation and non-maintenance has caused the new system to malfunction.

3. A recent example occurred when B-29 airplanes arrived in combat theaters with pneumatically operated bomb-bay doors. As instructions were not available, some crews operated the doors improperly with resultant inability to effect closure of the bomb bay doors after release of bombs during a combat mission. It has been reported that it was necessary for the ground crews to dissemble the pneumatic bomb bay door system in order to determine its functioning.

4. I am informed by Boeing Engineering Division that Handbook information in the fomr of pink temporary pages were prepared and ready for inserting in both Flight and Erection and Maintenance B-29 manuals of first airplane incorporating change 680, (pneumatic bomb bay doors systems).

This material was prepared at Debac, on basis of installation as first made at Omaha in sufficient time to get in the first airplane.

The general rule is that all pink temporary pages required for modification changes are prepared at Debac and distributed from there to other contractors and modification centers.

All pink pages for production changes for which engineering releases are made by Sebac are prepared by Sebac-Handbook Unit and distributed to all contractors and modifications centers from Seattle.

To the best of Boeings knowledge pink pages were inserted in the first airplane incorporating pneumatic bomb bay doors, however, the responsibility of placing the pink pages in the airplanes's "G" file is that of the contractor and local AFPR at the facility from which the airplane is delivered. (Reference ATSC regulation 5-A dated 23 September 1944).

Additional information on pneumatic bombbay doors in pink page form was prepared and released for all airplanes on 18 December 1944, 8 January 1945, 3 February 1945 and 2 March 1945, covering subsequent changes in the design.

5. Herewith for your information is a copy of pink pages describing the pneumatic bomb bay door system as revised as of 2 March 1945.

MARTIN P. HOOKER
Boeing Liaison Engineer.

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HEADQUARTERS, TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D.C.

15 February '45

MEMORANDUM TO: CHIEF OF STAFF,
Twentieth Air Force

Subject: Fuel Transfer System

1. When Dr. Landsberg returned from a recent visit to the XXI Bomber Command he commented upon a fact which has already been apparent from close attention to the reports of failures contained in the Mission Reports, towit: difficulties with the fuel transfer system.

2. I have asked Mr. M. P. Hooker, Boeing Liaison representative with this Headquarters, for comments upon this subject. His comments are attached hereto.

ROBERT I. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

1 Incl-Comments by
Mr. Hooker re: Fuel
Transfer System.

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HEADQUARTERS, TWENTIETH AIR FORCE
Office Of The Commanding General
Washington 25, D.C.

MPH/elw
14 February 1945

MEMORANDUM TO DOCTOR ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, CST

Subject: Fuel Transfer System

I. Manifold Fuel Transfer System.

1. With reference to our conversation regarding fuel transfer system failures which Dr. Landsberg reported on his return from the POA, you are advised that B-29 airplane change number 353, Manifold Fuel System Installation, is being engineered by Boeing at the present time to eliminate the fuel transfer system difficulties and also to provide a more flexible system.

2. The manifold fuel system eliminates the fuel transfer pumps and consists essentially of all tanks supplying a common line and each engine obtaining its fuel supply from the line. In addition, each main tank is directly connected to its respective engine. Electric motor shut-off valves with integral limit switches are installed in the fuel line connections to allow isolating a particular part of the system. Thus, should an engine fail and no longer require fuel, it is only necessary to block the supply to that engine by a shut-off valve or by the idle cut-off position of the mixture controls, and that fuel supply will become available to the other engines through the manifold.

3. The engineering proposal for this change will be submitted to A. T. S. C. approximately 16 February 1945. It is expected that this change will be incorporated in production airplanes by June.

II. Fuel Transfer Pump.

1. A. T. S. C. has directed that the present Romeo Carbon Vane Fuel Transfer Pump be replaced with Pesco Carbon Vane Pump 2P-307-C.

2. Boeing has recommended to A. T. S. C. that this change be handled as a modification and service installation for airplanes not incorporating change 353.

3. The Pesco representative at Seattle has advised that A. T. S. C. has ordered several thousand Pesco pumps for the change outlined in paragraph one, above.

III. Fuel Transfer System Failures.

1. Fuel transfer system failures were encountered in the B-29 airplanes of the XX Bomber Command during my service in that theater.



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2. The malfunctions of this system as of the date of my departure from that theater are listed and described as follows:

a. Carbon vanes of the Romeo pumps "broke-up" and caused the pumps to become inoperative. It is believed that this type of failure was caused by dirt, sludge, stones, etc., in the fuel, striking the vanes and causing them to disintegrate.

b. Fuel tank selector valves failing to open or close proper ports and leaking. Some of these failures were caused by dirt, sludge, stones lodging between the poppet and valve seat so the valve would not close. Other failures were caused by maintenance crews installing the valves incorrectly and failure to provide adequate cable tensions. Valve sticking was sometimes caused by corrosion and internal valve failure.

c. In some cases flight engineers failed to use correct procedures when transferring fuel with resultant failure of the system.

d. Sometimes the fuel transfer system was thought to be inoperative because of the slow rate of fuel transfer. The system is designed to transfer fuel at 1,800 gallons per hour at sea level, but at altitude this tranfer rate is much slower.

e. All other malfunctions of this system can be classified as electrical troubles such as broken wires, bad switches, "burned-up" motors, etc.

3. On some missions where the fuel transfer system failed to transfer fuel during flight it is believed that the system was inoperative prior to take-off for the mission.

4. Fuel transfer failures in the AK Bomber Command have been reduced to a minimum by thoroughly testing the fuel transfer system on the ground prior to each mission.

W. P. HOOKER
Boeing Liaison Engineer

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HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D. C.

5 April 45

MEMORANDUM FOR : DR. ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

Subject : Flare Dampeners B-29 Airplane

1. With reference to your request for data on the present status of flare dampners for the B-29 power plant installations, the following information is furnished.

2. Colonel G. B. Speir, Power Plant Division of M & S, advises that Wright Field is now conduction tests on a flare dampner for the B-29 airplane on a 2A priority.

This dampner is describe as similar to the unit used on the B-17 airplane.

If these tests are successful and the unit is installed on the B-29 airplane, it will cost approximately 440 pounds in a weight penalty.

3. The following information is quoted from a teletype from Boeing Airplane Company on this same subject:

"Some work has been done on heat exchangers for flame suppression but further development necessary to provide production installation. No flame suppressors available for present installation. Following correspondence on flame suppressors is quoted for your information.

From ATSC, dated 3-5-45 Quote - TSBPR312-3-97, contract AC-19673, B-29 airplanes. Subject - flame dampening, B-29 airplane. Confirming phone conversation between Mr. Ostlund of SBAC and ATSC Personnel 3 March 45 it is requested that contractor reopen flame dampening studies, B-29 airplanes; Present specifications call for no more than 300 feet visibility of flame at night. ATSC will conduct air to air visibility checks and will coordinate this program with contractor. Request comments by return TWX. Unquote.

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BAC reply dated March 19, 1945 Quote - Eng-T-4614-SE-3542C. Contract 19673, Model B-29 Airplane. Subject - flame dampening, B-29 airplanes. Reference - TSBPR312-3-97 dated March 5,1945. Contractor advises flame damping studies are being reopened per ATSC request in reference teletype. Review of all previous flame damping tests conducted by contractor on B-29 airplanes shows present requirement calling for no more than 300 feet visibility at night could not be met with any of the flame damping configurations tested. Two items which failed to meet the visibility requirement on all tests were the rear colltecto, from which a red glow was visible from the side and rear through the cowl flap exit, and the flight hood and waste exits, in which a red glow was visible from the rear at all times when external flaming was not evident. Effective screening of the rear collector/85wl exit will require cowl, cowl flap, and/or collector revisions with probale ill effects aerodynamically and on engine cooling.. Effective screening of the flight hood and waste exits will result in performance losses through decreased turbo efficiency and increased drag. Extension and additional shrouding of the flight hood will probably be required to effectively screen other glowing parts. These include the turbine wheel buckets, which are visible from the rear with the cutaway flight hood, and the external surface of the flight hood itself, which is visible as red glow during some flaming conditions. In addition to the above measures required to screen glowing parts, it will be necessary to provide for damping of external flaming. Installation of an exhaust gas heat exchanger proved to be the most effective solution to this problem, based on tests conducted by this contractor. Use of heat exchangers for this purpose either fore or aft of the turbo still result in some loss in turbo efficiency, which is indesirable as a major portion of B-29 operation is at conditions requiring turbo boost and cabin supercharging. Incorporation on the eight outlets and the eight sides of the four nacelles of flame damping equipment necessary to meet the present visibility requirement will also necessitate a substantial increase in weight. Equipment may be developed which will meet the visibility limit specified in Army-Navy specification AN*D*10 dated 29 November 1943 but at the expense of airplane performance. It is problematical whether an installation which meets the visibility requirement will also meet the performance, design and construction, and detachability requirements of the subject specification. To permit further studies, contractor desires consideration of specification changes and information as to the actual combat requirements which the design should meet. In view of the complication and performance loss expected, contractor believes further work on this subject not warranted at this time when compared to high priority items for production which

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are already utilizing available manpower. Unquote.

ATSC Reply to above dated March30,1945 Quote - TSBPR312-3-660. Contract AC-19673, B-29 air plane. Flame damping, B-29 airplanes, Reference - /A/eng-T-4614-SE-3542C, dated 19 March 1945 /B/TSBPR312-3-97 dated 5 March 1945. In view of contractor's comments in reference /A/ it is requested that engineering study as requested in reference /B/ be suspended until further notice. Unquote."

Marvin P. Hooker
Boeing Consultant

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25 April 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS.

Subject : All-Weather Engine Stand.

The necessity for an all-weather engine stand for B-29 maintenance has been accepted by those concerned in the field, This requirement was placed before the Twentieth Air Force, A-4 Section, with the request it be expedited with the greatest of speed. An inttial contract followed for 360 of these stands which are now being manufactured at the rate of four a day. This rate may increase up to eight per day as job efficiency increases with experience. However, the first stand on a production basis had not been made as of 15 April and a regular production rate will not have been established for about two weeks from this date. It is easy to see that the requirements for May and June, when the rains begin to assume important proporations, that no stands will be available in the theatre. The maximum rainfall is encountered during August with an average fall of 18 inches per month and rain occuring from 24 to 26 days out of the month.

It was originally recommended that 1500 stands be procured, the 360 stands contracted for was an immediate requirement and this number offered the advantages of quick procurement while design and future requirements received further study.

The design is now proven and equipment requirements because of the activation of the XX Bomber Command will call for far more that the 1500 originally asked for. This even at a bare minimum of one per aircraft. Also domestic demands may be considered.

If contracts were not secured for additional stands within two weeks from April 15th, the process of procurement for various materials would have to be reactivated. Also loss of sub-contracting sources would be experienced. This will delay the program three for four months. On the other hand the prime contractor can and will guarantee to deliver twenty stands per day if assured the total number of stands will exceed 1000.

This informations was passed on to A-4 upon my return from Wright Field and contacts were made with Requirements and Procurement in their company and under their guidance. A*$ had also been contacted prior to my departure for Wright Field, at which time my plans were discussed.

Upon the return of Major Gurney, A*$, who was originally concerned with the enginestand requirements a very unpleasant talk took place wherein it was stated my activities were out of order and he would see to that I conformed to what he ordered. My contact with Colonel Fisher was resented and I was told that I should have come to him. Inasmuch as all phases

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of my progress were in constant association with A-4, his office, I could not appreciate his position.

The XX and XXI Bomber Commands still need the stands and the status of procurement is of great importance. If the procurement has progressed only the lines under way at the time of Major Gurney's return the situation will nee only such follow up as is normally required. If not then steps should be taken to secure the engine stands in the most advantageous manner at once.

Of importance is the procurement of pre-oiler units, flushing units, aero stands and 600 amp. generator units. I have not been able to get an accurate picture on these items but some means should be found to assure their quick delivery in the field.

WAND AC LAREN
Operation Analyst
Operations Analysis Division
Twentieth Air Force

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10 April 45

MEMORANDUM FOR: DR. ROBERT L. STEARNS, Chief
Operations Analysis Division, Twentieth Air Force

Subject: On the Distribution of Engine "Life" to Removal in Overhauled B-29 Engines.

1. There has been received a Summary of XXI Bomber Command experience with B-29 engines to 20 February 45. For Theater purposes, attention is given particularly to the over-all requirements for the flow of replacement engines, and to predicting number of engine changes expected when the distribution of accrued time on engines and the predicted flying time are known. In the data of this Summary, it is not always possible to separate overhauls due to operating mishaps from those incidental to battle damage; however, the latter (45 in number) are only 14 percent of the 310 engines considered, and the mean service time for them (153 hours) is not very different from the 161 hours found for engine removals due to malfunction.

2. It was sought to use these data and other figures from similar earlier Reports from XX and XXI Bomber Commands, and from domestic activities, for the illustration of a kind of "performance control" process with respect to R-3350 "fully modified" engines. Domestic area data were obtained from the Five-day Summaries of Engines Overhauled (ATSC). Two features of these general data are of particular interest: (1) the average "life" to removal for overhaul, and (11) the dispersion or spread of the individual times-to-removal (standard deviation).

3. It has been found that the distribution of time-to-removal is surprisingly regular: it follows the so-called "Normal distribution" curve. One of the simplest and most convenient ways of dealing with such distributions is to sum the frequencies at progressively spaced removal-times. On a special plotting paper (Figure 1) adapted for the display of normal probability distributions, the summed frequencies appear to lie upon or near to a straight line if the distribution considered is, in fact, sufficiently "normal". (Figure 2, Figure 3). From the position of the line upon the grid, the mean and the standard deviation can be obtained with quite sufficient accuracy be inspection (the size of the sample is made equal to 100 for purposes of comparison of samples).

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4. Distributions of this type can be expected to be normal (in samples of the numerical size here considered) only if certain kinds of heterogeneity are removed. Thus Wright-built and Chrysler-built engines give different distributions. New engines, once over-hauled and twice-overhauled, give quite different distributions. For illustration of "performance control" we deal here with new engines - not previously overhauled. It is also a minor source of heterogeneity that invoard engines are less sturdy than outboards. In the current Report from XXI Bomber Command, we find 133 outboards, 164 inboards removed, a ratio of 1:1.23, after mean usable life-times of 168 and 150 hours respectively. (This particular series includes some battle damage cases; in other series, not including battle damage, the difference is greater). A different type of heterogeneity is involved in the circumstance that some "failed" engines do not survive for overhaul, or may be lost in crashes; the life-times on these are not readily available; the proportion of such engines in the total is, however, small.

5. There are two aspects of operational engine failures (as distinct from combat effects) which are to be taken into account: the percentage of engines failing, and the distribution-in-time function for those which do not fail within the time-limit fixed by practice. This time-limit is itself not constant, invariable. Attention is given here only to the distribution-in-time of the Failed engines. We can compare in this way the properties of groups of failed engines occuring under different conditions of operation; produced by different factories; and at different periods of time. (The date here considered are grouped with respect to time of failure or time of overhaul, not necessarily corresponding to time-order of manufacture; or modification; for purposes of performance control it could be quite important to be able to follow through to the dates of factory changes in relation to the occurence of certain troubles.

6. As a rather rough illustration, which at the same time shows the way in which the mean life-time of failed engines and the index of dispersion of the times-to-failure (standard deviation $\sigma$), vary with circumstances, several sets of data are taken on the accompanying graphs. In these graphs the "best" straight lines on the probability grid have been transferred to ordinary arithmetic coordinates; they are thus essentially calculated curves.

a. As a relatively stable situation, the B-17 engine failure data (B-1820) for January and February 45, domestic area, new, all makes of engine, are shown (Fig. 4). Overhauls dictated by "allowable operating time", handling, shipping, warehousing, modifications and accessories" have been excluded. The mean life



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expectancy in the group of failed engines is approximately 400 hours. The "spread" is great ($\sigma$ = ca. 205 hrs). The January and February curves differ but little (and are practically identical with the November, December curves (not shown here). In contrast, the mean time for B-29 engines in February '45 in successive samples, 1-10 February and 11-20, domestic (and also overseas) is quite short - of the order of 170 hours, and the dispersion is small ($\sigma$ = ca. 78 hrs.)

b. A first overhaul reduces the mean survival time distinctly, andincreases the dispersion (Fig. 5). Wright Paterson engines show a less-dispersed assemblage of failed engines, as regards running time, to first overhaul, than do Chrysler (Dodge) and a longer mean running span. Overseas, a little better performance has been given by the groups of failed engines than domestically, but the curves do not differ greatly.

c. It is an interesting fact that overhauls (for all causes) in XX and in XXI Bomber Commands give curves which are almost identical (Figs. 5, 6.) (The curve for engine malfunctions proper, as distinct from "excess oil consumption" and the like, is pitched at a slightly lower time level, but has essentially the same shape:) mean "life" = 178 hrs; $\sigma$ = 73 hrs.)

7. Several suggestions emerge (a) The B-17 power plant as a whole, with respect to its representatives requiring overhaul (for the most part premature), is about 2.4 times as good, under the conditions of its use, as is that of the B-29. The indices of scatter of the "survival times" ($\sigma$'s) are in precisely the same ratio.

b. In recent months there has been some progressive improvement in the mean life expectancy with new, modified B-29 engines and with increasing skill in their maintenance, This does not mean, however, that the failed engines have been an improved group. In November '44, the mean life to required overhaul for new domestic B-29 engines was 220 hours; in February '45, 135 hours, the curves being of nearly the same shape. No very firm suggestion can be made as to why this should be so, but those engines which do require overhaul, with only slightly increased homogeneity as a group, do so in a shorter time. It is possible that they are now worked more severely. There does not seem to have been a concentration of "causes", at least none detected as yet, although further analysis may be helpful.

c. As regards the service times at which overhaul becomes necessary, it is impossible to hold that any small number of causes is in general determinative. A reduction of the number of sources of the failures, so that a progressively smaller fraction of engines requires "premature" overhaul each month, might lead to a situation in which, while a smaller fraction of the total population of engines

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is found to fail to the point of requiring overhaul, it fails after a shorter mean time. Such a group might include the effects of a rather small number of major causes, and the frequency distribution might still be "normal" because many factors will influence the precise running time at which failure will occur in different engines. The data on B-29 engines do show pretty clearly that with time there has been a reduction in the mean life of samples of overhauled engines, through February 1945, although there is a lowering of the proportion of failed engines in the total population. This has been true domestically as well as overseas.

d. The distribution curves for data from XX and XXI Bomber Commands are practically identical. Moreover, they do not differ essentially from the curves for recent domestic overhauls, although the overseas groups give curves pitched at a slightly longer life-time. The $\sigma$'s are of about the same magnitude. This clearly implies that the condition illustrated in the B-29 engines is the result of the nature of these engines in relation to the work they are called upon to do, and not upon local conditions. This is, of course, confirmed by the fact that the product from different factories (Wright, Paterson, Dodge) give different curves in the same area; in general, Chrysler (Dodge) failed engines overhauled do so at a shorter mean life-time (Figure 7) and the frequency distribution is a little more widely scattered ( $\sigma$ is larger.)

e. It would be of value to carry such analyses further, even by purely graphic methods. In the XXI Bomber Command Report the distribution curve for survival time on failed malfunctioning engines has a mean of 178 hours, $\sigma = \pm 73.7$ hours. The data on engines failed as result of cylinder troubles alone gives mean life of 163 hours, and the integral curve is steeper ( $\sigma = \pm 67$ hours; Figure 3). It is interesting that for amore specific category of engine failures, such as cylinder failure, the normal distribution is still quite satisfactorily obeyed, and that, as would be expected, $\sigma$ is smaller than for an equivalent sample of engines including instances of failure from other causes. The number of cylinders is small in this sample, - but note that for the 88 engines, 1,560 cylinders are exposed to risk.

8. In certain cases an exaggerated "tail" appears at the left (the low life-time end) of such graphs (Figure 7). There appears an excess over expectancy in the number of early failures. This is clearly due in the main, to the fact that mechanical conditions which should have been noted during manufacturing inspection have escaped detection. (Analagous circumstances appear in other applications of the probability law, and do not interfere with the use of the law for the rest of the distribution).

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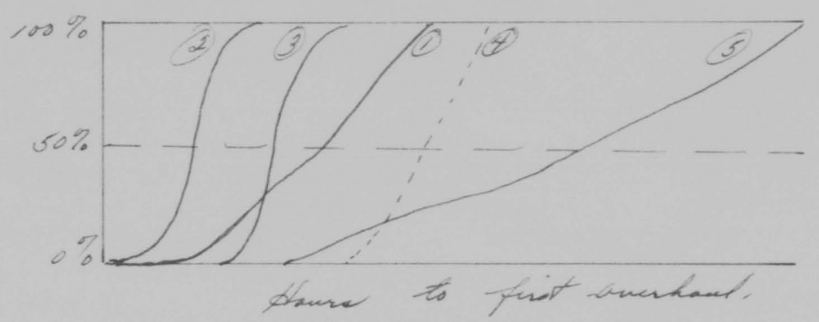
9. It may be asked, "What is to be the expected time-course of the frequency distribution of times-tofailure among overhauled engines during a sufficiently lengthy period of development of a power-plant installation?" Deductively, the indication is that one may expect something of the sort diagrammed here - where sample distributions taken at intervals during a period of development numbered in chronological sequence:




The (domestic) data seem to show, for the first time, real sign of the kind of improvement which could be expected (Figure 8); the dispersion of time-to-removal (Wright, Peterson engines) is less for March 1945 than for February, and the mean life-time is significantly increased. This corresponds to a change intermediate between steps 2 and 3 in the diagram. Up to this time the shift has been of the type 1 to 2 (cf. Figure 5).

8 Incls
8 Graphs

W. J. CROZIER
Operations Analyst

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FIGURES

1. Probability paper

2. Example of a summed frequency distribution of service time on engines removed for overhaul (June, 1944, XXBomber Command)

3. Example of a frequency distribution of engine "life" for engines overhauled for a single general reason (cylinder failure)

4. Contrasts: B-17 engines, time to overhaul (all causes, domestic); B-29 engines (all causes), XX and XXI Bomber Commands, and (XXI Bomber Command) engine malfunctions alone.

5. Engine-life frequency distributions for (domestic) B-29 engines for November '44 and February '45; and for second overhauls (November '44).

6. Engine-life frequency distributions for overhauled engines, XXI Bomber Command and XX Bomber Command.

7. Engine-life frequency curves for Wright-built and Chrysler-built (domestic) B-29 engines.

8 Engine-life for (domestic) B-29 engines in February '45 and in March '45.

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FIG. 1

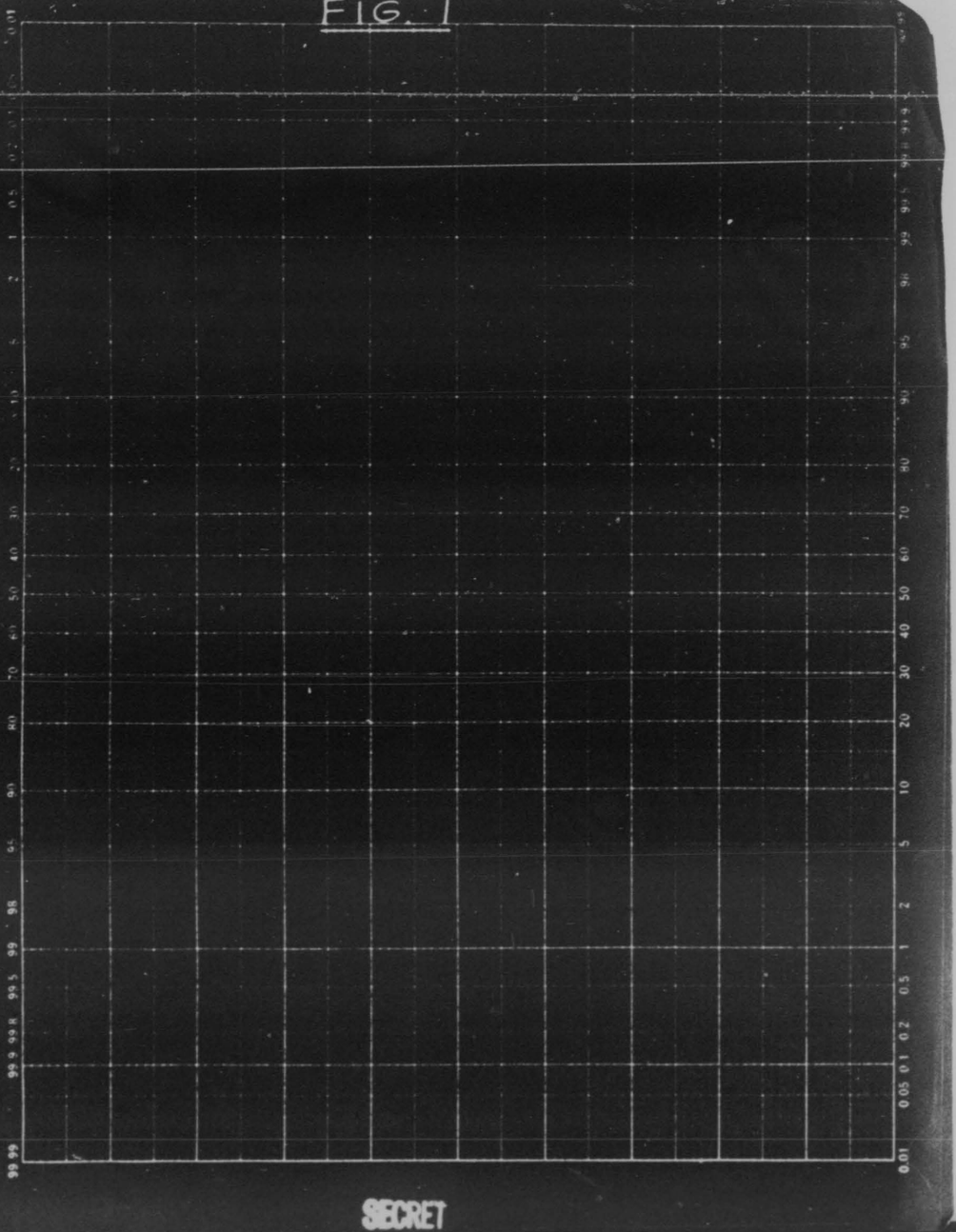

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Fig. 44.

XX B.C. R-3350 ENGINES
REMOVED FOR OVERHAUL
JUNE 1944. 150 CASES
(n' = 150.5).

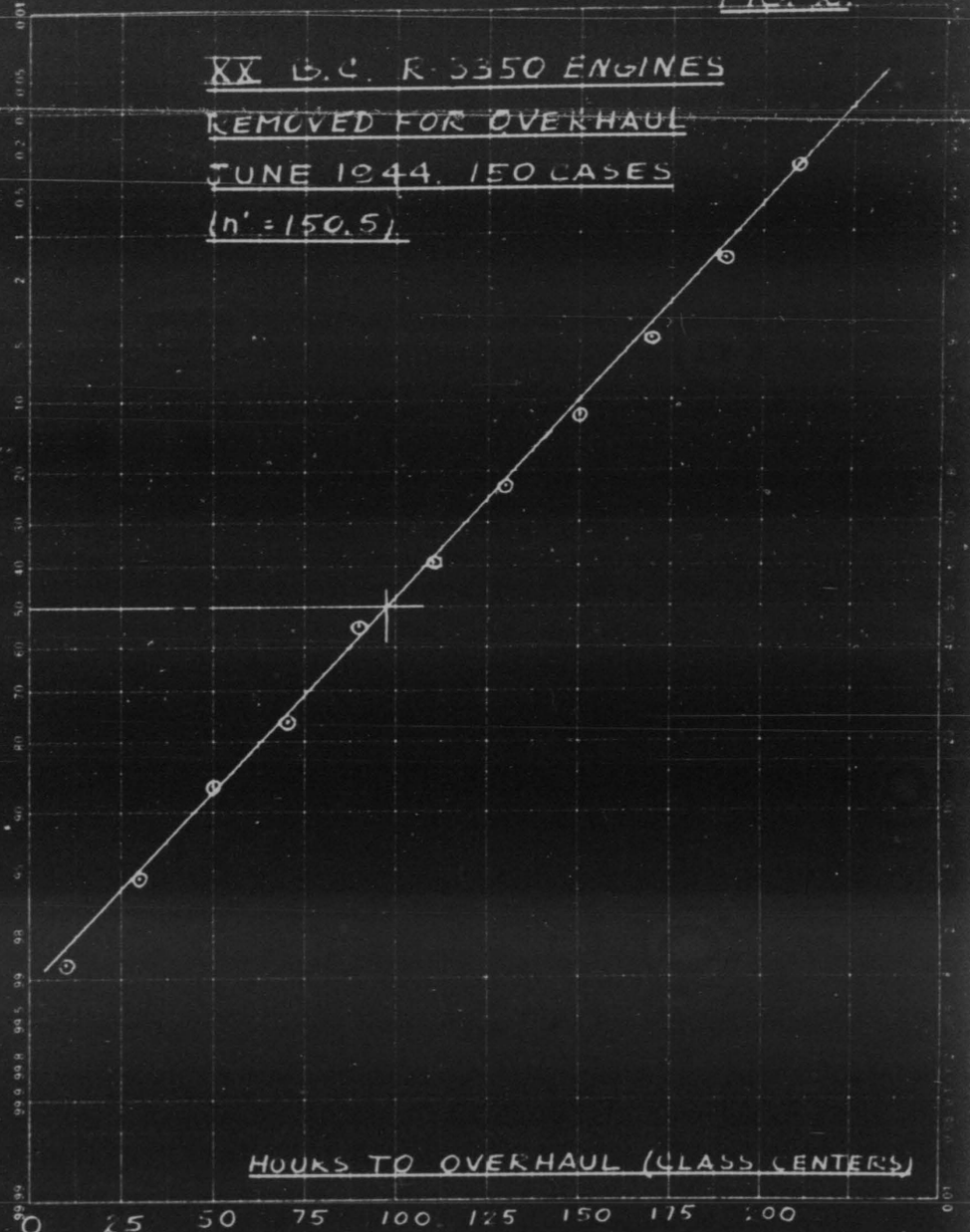


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FIG. 3

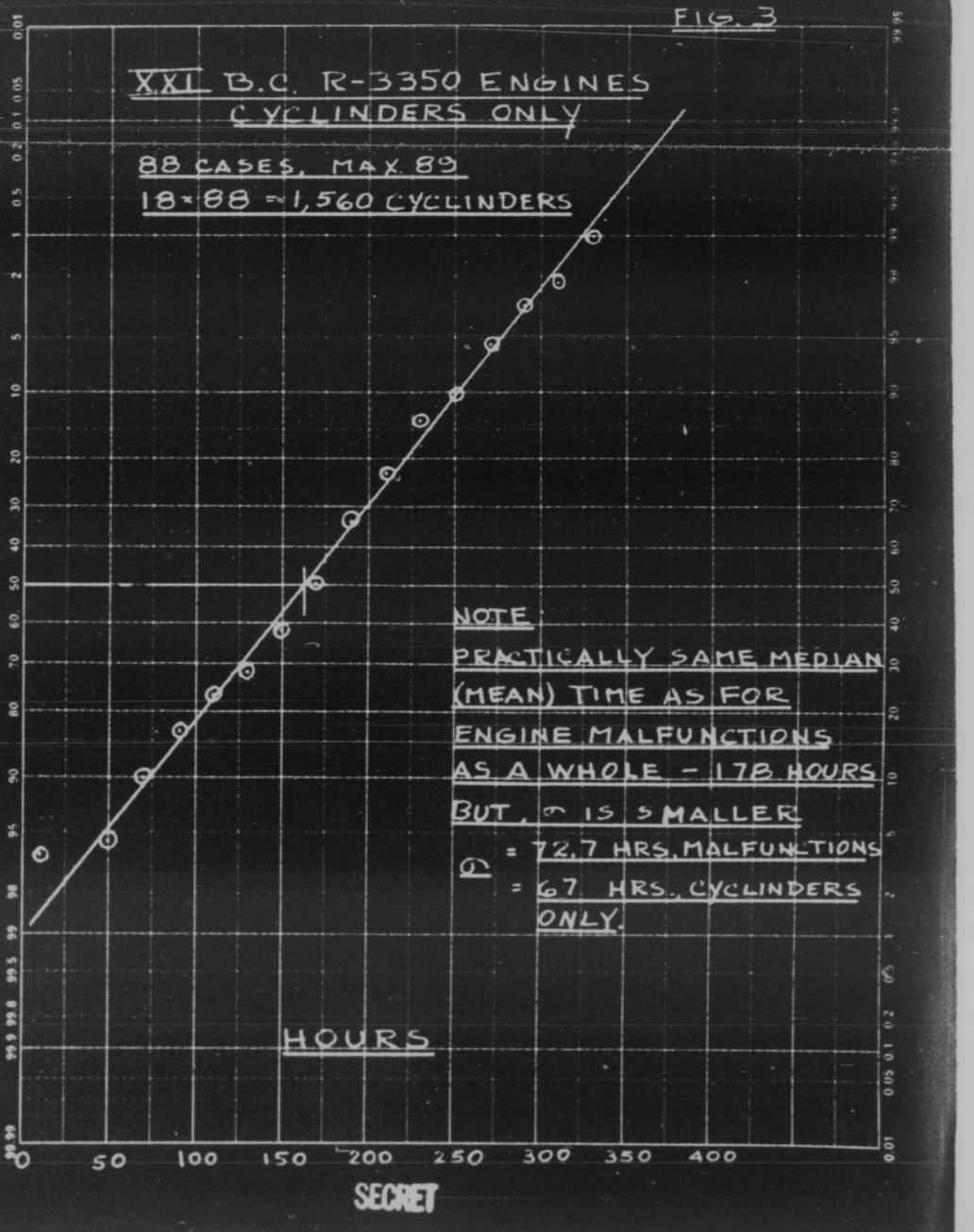


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Fig. 4

B-17 AIRPLANE - R-1820 ENGINE - DOMESTIC - ALL MAKES

○ = JAN. 1945 (5, 7, 8, 9 EXCLUDED) 516 CASES MAX. 518

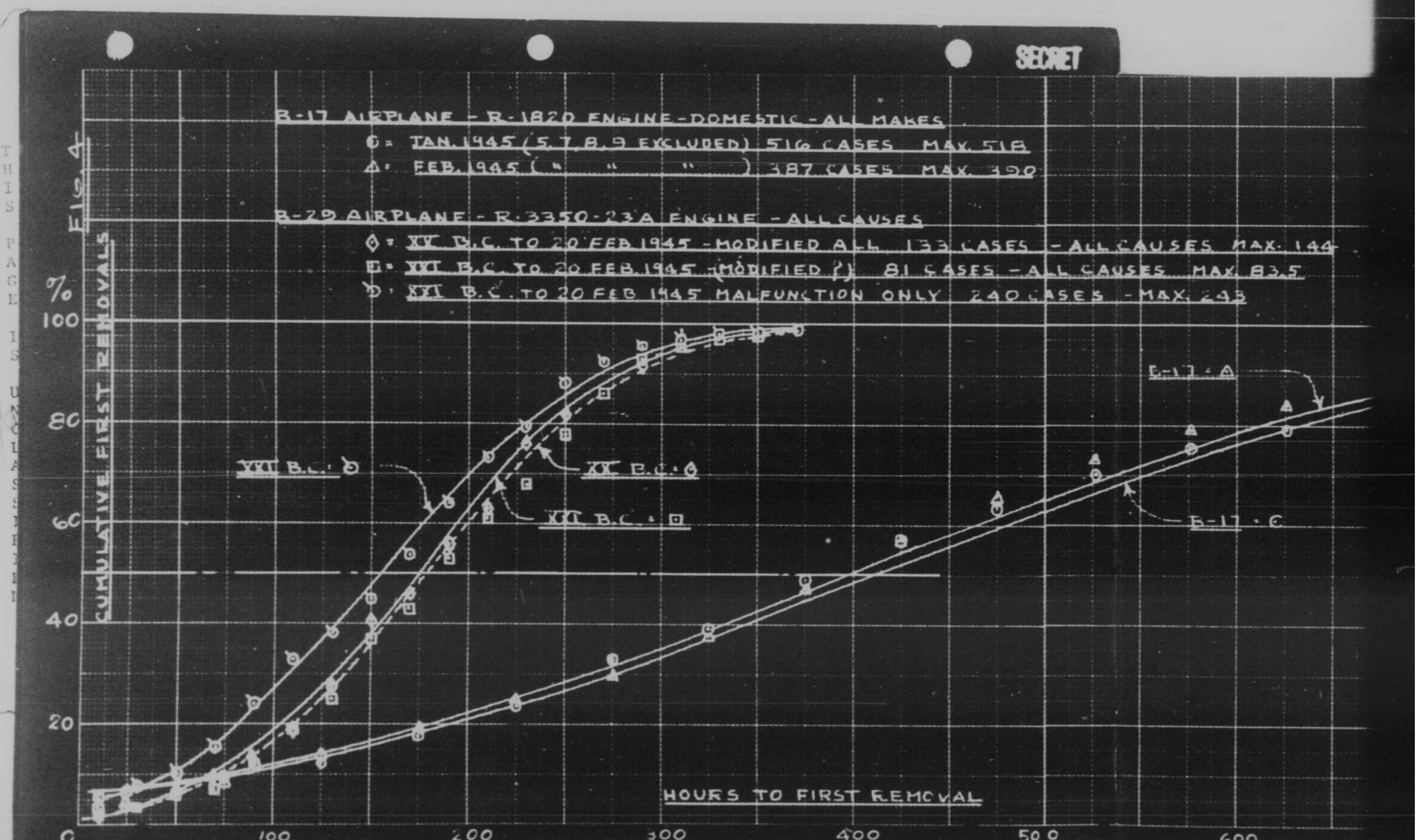
△ = FEB. 1945 ( " " " ) 387 CASES MAX. 390

B-29 AIRPLANE - R-3350-23A ENGINE - ALL CAUSES

◇ = XX B.C. TO 20 FEB 1945 - MODIFIED A-4 133 CASES - ALL CAUSES MAX. 144

□ = XXI B.C. TO 20 FEB 1945 (MODIFIED ?) 81 CASES - ALL CAUSES MAX. 83.5

◁ = XXI B.C. TO 20 FEB 1945 MALFUNCTION ONLY 240 CASES - MAX. 293

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OMESTIC - ALL MAKES
ED) 516 CASES MAX. 518
) 387 CASES MAX. 390

INE - ALL CAUSES
MODIFIED A-L 133 CASES - ALL CAUSES MAX. 144
MODIFIED (-) 81 CASES - ALL CAUSES MAX. 83.5
MALFUNCTION ONLY 240 CASES - MAX. 248

E-17 · A

E-17 · C

OURS TO FIRST REMOVAL

0 400 500 600 700 800 900 1000

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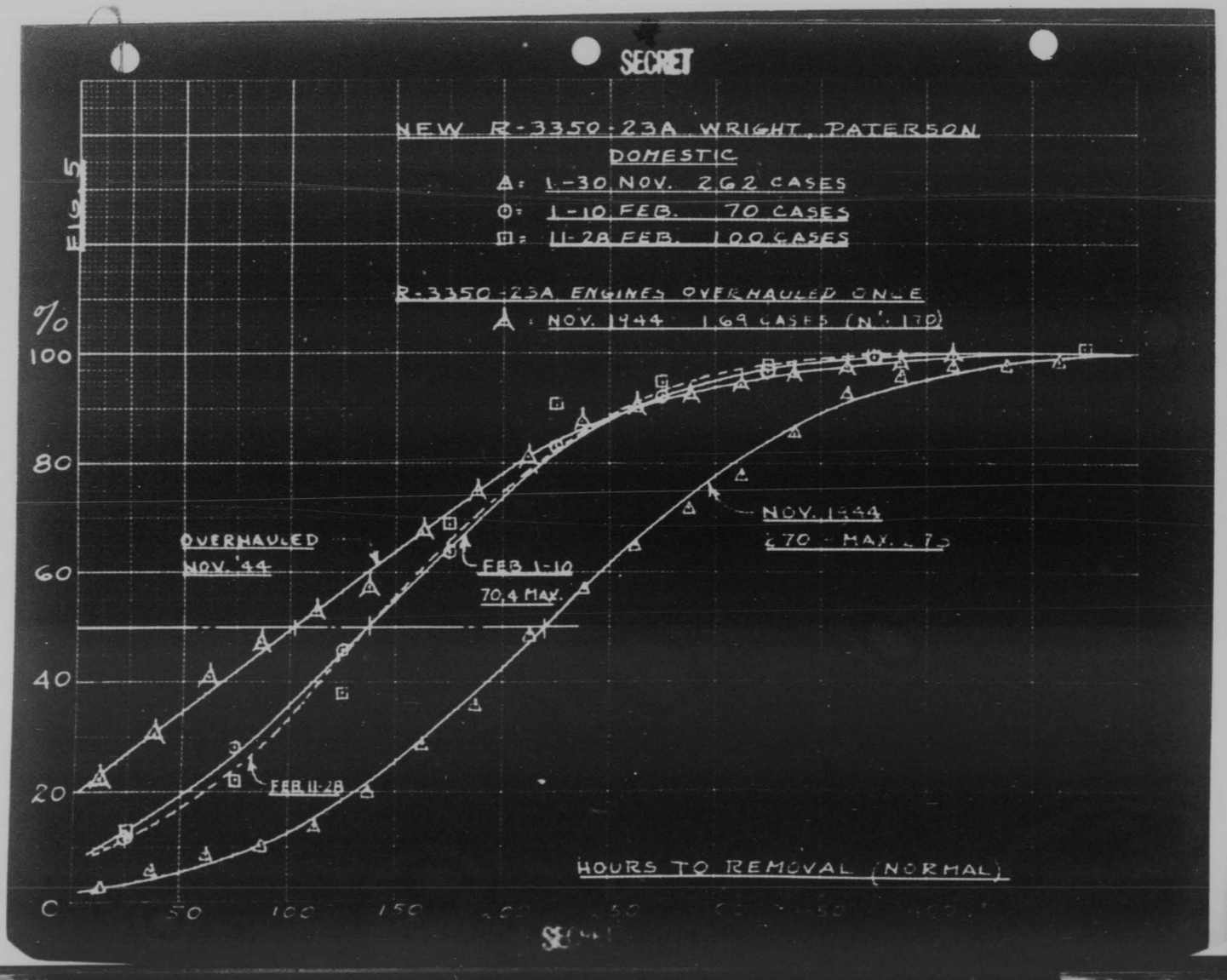


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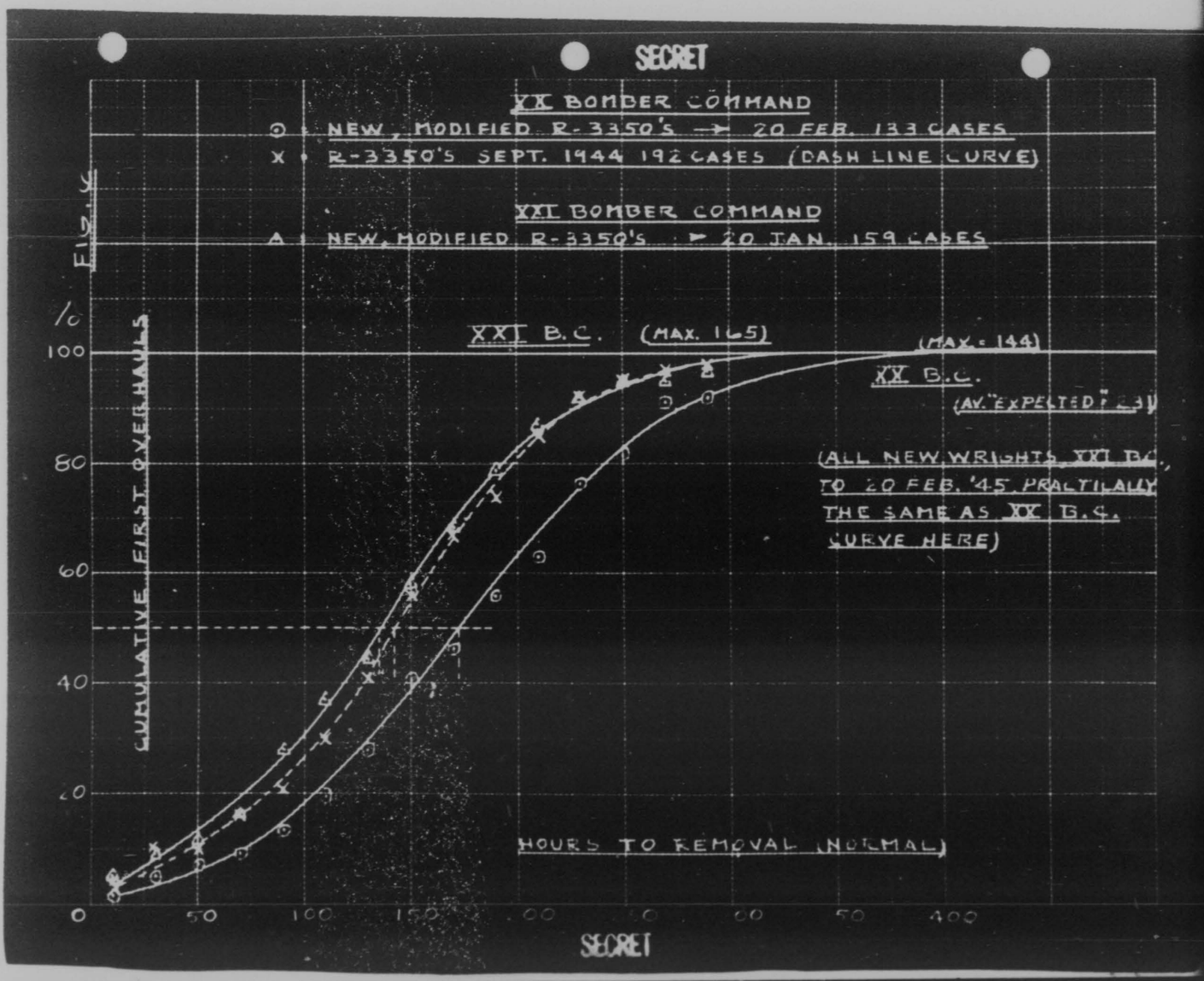


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FIG 5

NEW R-3350-23A WRIGHT, PATERSON

DOMESTIC

A: 1-30 NOV. 262 CASES

O: 1-10 FEB. 70 CASES

□: 11-28 FEB. 100 CASES

R-3350-23A ENGINES OVERHAULED ONLY

A: NOV. 1944 169 CASES (N. LTD)

%

100

80

60

40

20

0

OVERHAULED NOV. '44

FEB 1-10 70.4 MAX.

NOV. 1944 270 MAX. 7

FEB 11-28

HOURS TO REMOVAL (NORMAL)

50 100 150

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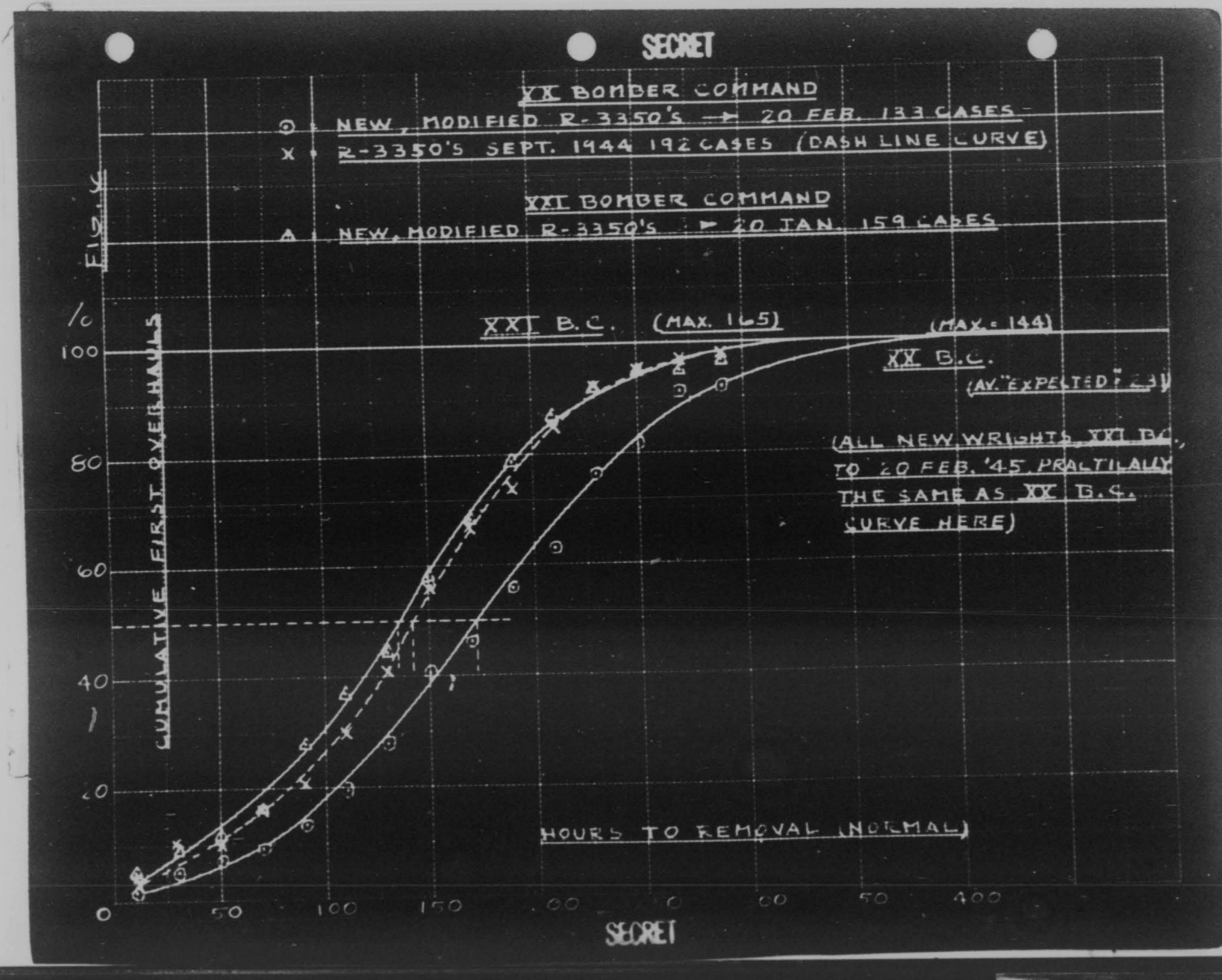


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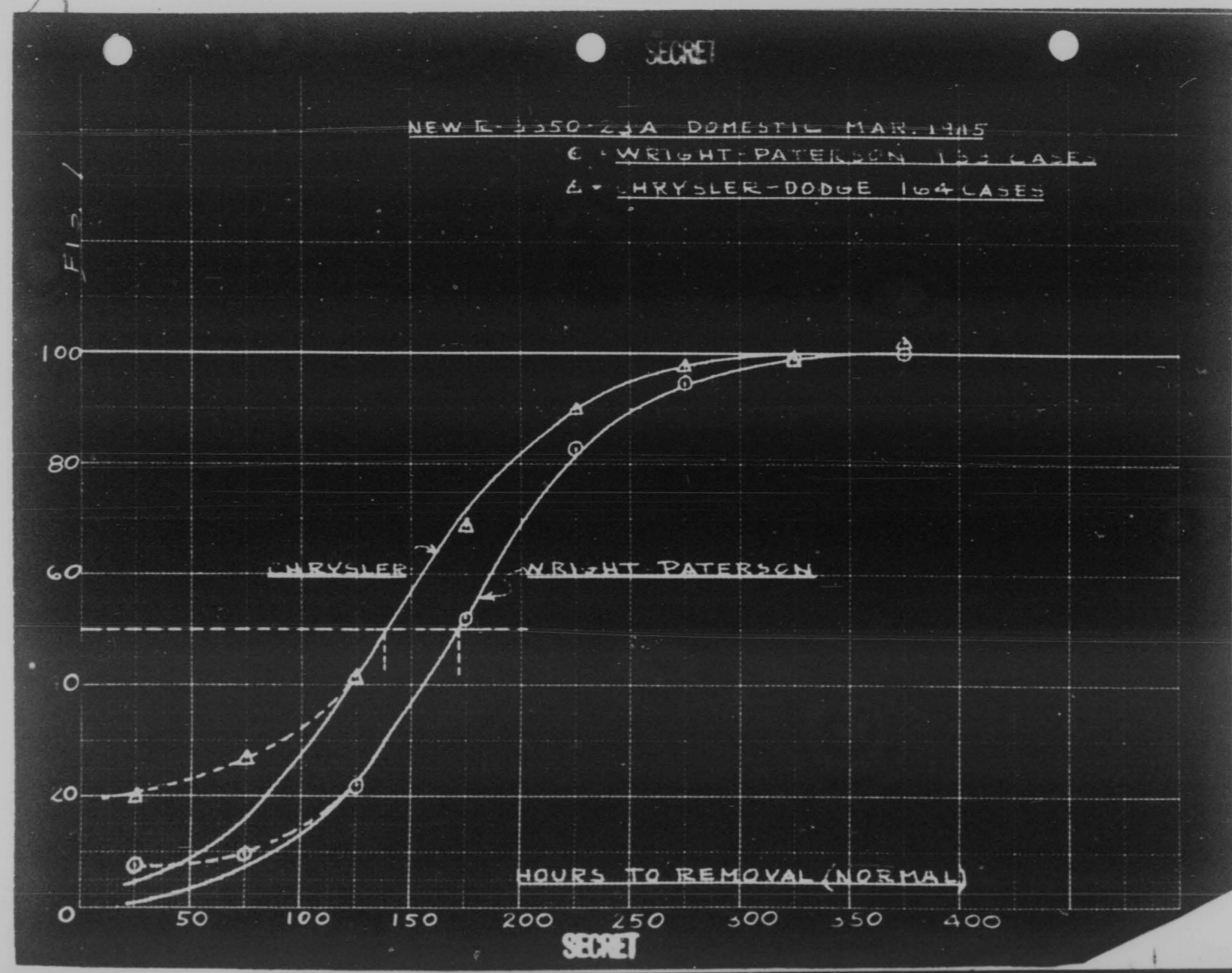
NEW E-3350-23A DOMESTIC MAR. 1945

C - WRIGHT-PATERSON 152 CASES

A - CHRYSLER-DODGE 164 CASES

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NEW R-3350-23A WRIGHT PATERSON

DOMESTIC

O = FEB. 170 CASES

Δ = MAR. 65 CASES

Fig. 8

%

100

80

60

40

20

0

FEB 1945

MAR. 1945

50 100 150 200 250 300 350 400

HOURS TO REMOVAL (NORMAL)

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BOMBING



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AIR FORCES MANUAL No. 79

# BOMBING CHARTS

1 TARGET CHART
2 FORMATION BOMBING CHART
3 SINGLE HIT CHART
4 PATTERN EFFICIENCY CHART
5 CONVERSION CHART
6 PATTERN DISPERSION CHART

APRIL 1945

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HEADQUARTERS, ARMY AIR FORCES
Washington, 30 April 1945

Air Forces Manual No. 79 *Bombing Charts* is published for the information and guidance of all concerned.

BY COMMAND OF GENERAL ARNOLD:

BARNEY M. GILES
Lieutenant General, United States Army
Deputy Commander, Army Air Forces

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## PRELIMINARY

**Reasons for considering bombing expectancy.** Although it is an Air Forces maxim that the objective of a bombing group is to place its bombs on the assigned target area, combat bombing operations are normally conducted under such circumstances that only a proportion of the bombs dropped can be expected to strike the target. Accordingly there arise aspects of the bombing problem which require an estimate of this proportion in advance for the proper consideration and planning of a mission. If a particular target is to be bombed, such an estimate can serve as a basis for determining the size of the force that should be dispatched to accomplish the desired result. The estimate also discloses whether or not there is a substantial likelihood that the force available for the mission can achieve the required concentration. Such estimates can strongly influence the choice of targets, since they may reveal that there is a very small chance of success against some of them and that in consequence the effort could be expended more profitably against those which there is a reasonable chance of striking with the essential minimum number of bombs. And in the overall prospect of extended operations, estimates are necessary for planning purposes because they indicate the total number of sorties required for the destruction of a list of priority targets.

**The bombing charts.** For the purpose of expediting the calculation of bombing expectancy the charts presented in the following pages have been prepared to give quick answers to various bombing problems.

**Chart 1: Target Chart.** The Target Chart gives an answer with a minute or two of simple computation to a question fundamental to bombing operations: *What percentage of the bombs to be dropped may be expected actually to strike in the target area?*

**Chart 2: Formation Bombing Chart.** Because of the prevailing practice of reporting in terms of the percentage of bombs falling with 1000 feet of the aiming point,* the Formation Bombing Chart has been prepared to accommodate the special interest which is created in a target area of that size. For a target equal in area to a 1000-foot circle it provides the same answer that Chart 1 provides but more conveniently in

*"Aiming point" should be taken throughout to mean the point upon which it is desired to center the bomb pattern.





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that it can be entered directly with the pattern dimension and the aiming error in order to obtain the expected percentage.

**Chart 3: Single-Hit Chart.** The Single-Hit Chart is also for a special use: it has been prepared for the easy estimation of the chance of obtaining at least one hit on the very small target which may be destroyed by a single hit.

**Chart 4: Pattern Efficiency Chart.** The Pattern Efficiency Chart is derived from Chart 1 to give curves showing the efficiency of bombing by various sizes of patterns in comparison with bombing by individual aircraft.

**Chart 5: Conversion Chart.** The Conversion Chart deals with a problem of occasional interest. When the radius of the circle about the aiming point which incloses one half the bombs dropped is known, this chart permits its conversion directly to the per cent of bombs expected within 1000 feet and 2000 feet of the aiming point.

**Chart 6: Pattern Dispersion Chart.** The Pattern Dispersion Chart reveals the important effect that size of pattern has on bomb dispersion.

**Bases of the bombing charts.** The bombing charts described are based on two conveniently simple generalizations which, although they do not precisely describe individual combat instances, nevertheless are in sufficient accord to yield a satisfactorily close agreement between the results observed in combat bombing and the values read from the charts. Accumulated evidence indicates that these assumptions may be employed with confidence.

**First assumption:** That the aiming errors will be normally distributed with equal range and deflection errors. The radial error can therefore be used. It is taken as the radial distance from the center of the bomb pattern to the assigned aiming point upon which it was desired to center the bomb pattern. In Charts 2, 5, and 6 the aiming error of the pattern center is expressed in Cep units. For these it must be understood that the Cep is to be taken as the radius of the circle about the aiming point which contains one half of the **centers of the bomb patterns** and is equal to 0.939 times the average radial error.

**Second assumption:** That the bomb pattern is rectangular and the bombs are scattered regularly over its area. In actual practice bomb patterns are irregular in outline, usually



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being somewhat longer along track than across track, and the bomb density decreases toward the edges. But provided that the length does not exceed twice the width, the actual bomb pattern may safely be replaced for theoretical purposes by a square pattern of equivalent area. The lack of uniformity in bomb density works to make a real pattern equivalent in result to a somewhat smaller theoretical square pattern so that, as a consequence, the charts tend to underestimate the expected percentage of bombs on small targets.

**A convenient expedient.** Computation and complication have been very much reduced by an expedient adopted in setting up several of the charts. Instead of conventional measurement in feet a unit equal to the average radial error is used to measure the dimensions of pattern and target. Thus if a target 2700 feet square is to be bombed with a pattern 1800 feet square and the average radial error of the pattern centers is 900 feet, the resulting bombing problem can be expressed as that of bombing a target of 3.0 units with a pattern of 2.0 units dropped with a radial error of 1.0 unit. This bombing problem is therefore disclosed as exactly the same as that of bombing a target 2100 feet square with a pattern 1400 feet square dropped with an average radial error of 700 feet.

**Caution. a.** It must be remembered that bombing expectancy as estimated with the charts is the percentage of hits with the bombs dropped by the airplanes remaining after abortives and gross errors are deducted.

**b.** It must be realized that generalizations describe averages, not particular instances. Expectancy values obtained from the charts are based on average aiming errors and average pattern sizes as determined over a period of operations. But in the individual missions, especially when a target is attacked by a small number of formations, results often exceed prediction and often fall short, since with a small number of aiming operations the chance combination of a series of very small or a series of rather large aiming errors is not unusual. Conditions encountered on a particular mission also may be more or less favorable than the average. Yet, in spite of these uncontrollable uncertainties which may apply to individual missions, long-run results will be in accord with predicted expectations.





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## TARGET CHART

**The target chart** functions to determine the per cent of the bombs dropped which can be expected to hit the target area. To use it, the size of the pattern and the accuracy of the bombing in terms of average radial error of the pattern centers (for attacks by individual aircraft the Cep or the average radial error of bombs dropped) must be known.

**The curves** marked **1, 2, 3,** and **4** are used for patterns 1, 2, 3, or 4 times as large in their dimensions as the average aiming error. The curve marked **0** is for individual aimings (zero pattern size).

**Use of the chart** depends upon the shape of the target and the pattern, that is, whether they are (1) square, (2) rectangular, but with length not exceeding twice the width, or (3) rectangular, but long in proportion to the width. There are three corresponding methods. Irregular targets and patterns are replaced by squares of equal area or by rectangles of equal area maintaining approximate proportions.

**Method 1: For square target and pattern.** Divide the side of the target and the side of the pattern by the average radial error. Enter the base line of the chart with the quotient obtained for the target dimension and read up to the curve corresponding to the quotient for the pattern dimension, interpolating between the curves if necessary. The per cent of bombs which can be expected to strike the target can now be read directly from the vertical scale.

**Method 2: For rectangular target and pattern, length not to exceed twice the width.** Convert target and pattern to squares of equal area and proceed as in Method 1.

**Method 3: For rectangular target and pattern, long in proportion to width.** Method 1 is used to obtain an answer for a square target and a square pattern with dimensions equal to the **length** of the actual target and the **length** of the actual pattern. Then an answer is also obtained by Method 1 for a square target and a square pattern with dimensions equal to the **width** of the actual target and the **width** of the actual pattern. The two answers are multiplied, and the square root of the product is taken by consulting the table of squares (back cover). This square root equals the per cent of bombs to be expected on the actual target.



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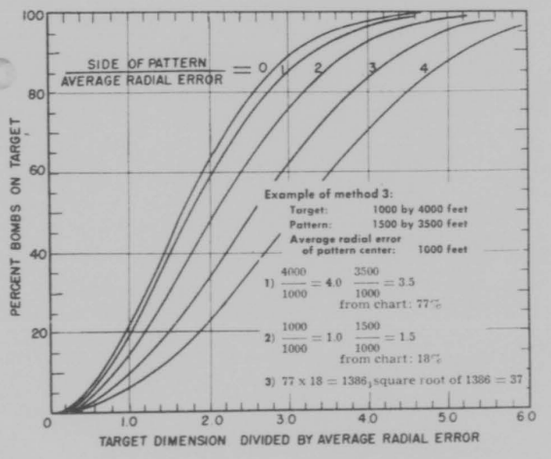
## Chart 1 — Target Chart




### Table of Per Cents for Small Targets

| Curve | Target Dimension Divided by Average Radial Error | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | .05 | .10 | .15 | .20 | .25 | .30 | .35 | .40 | .45 | .50 |
| 0 | .06 | .25 | .56 | 1.00 | 1.55 | 2.22 | 3.01 | 3.92 | 4.95 | 6.05 |
| 1 | .06 | .22 | .49 | .88 | 1.37 | 1.96 | 2.66 | 3.46 | 4.36 | 5.35 |
| 2 | .04 | .16 | .35 | .62 | .97 | 1.40 | 1.89 | 2.46 | 3.11 | 3.83 |
| 3 | .03 | .10 | .22 | .39 | .61 | .88 | 1.20 | 1.56 | 1.97 | 2.43 |
| 4 | .02 | .06 | .14 | .24 | .38 | .55 | .75 | .97 | 1.23 | 1.52 |

The above table gives the expected percentages of bombs on small targets more accurately than they can be read from the curves on the chart.



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## FORMATION BOMBING CHART 2

**The Formation Bombing Chart*** is used to obtain the per cent of bombs dropped which may be expected to fall within 1000 feet of the aiming point for any given average size of pattern and average aiming error. It is evident from this chart that if the pattern dimension exceeds twice the aiming error, the bombing will be greatly improved by a reduction in the size of the pattern.

**The reliability** of the Formation Bombing Chart is indicated by comparing bombing data and results from the Eighth Air Force with the expectancy predicted by the chart for the same data, computation of which will also serve as an example of the use of the chart.

**Eighth Air Force Data and Results**

| Period of time | Average area of pattern in sq. ft. | Average radial error in feet | Per cent of bombs within 1000 ft. |
|---|---|---|---|
| 1 Jan 43—1 Oct 43 | 9,500,000 | 1200 | 24 |
| 1 Oct 43—1 Mar 44 | 5,720,000 | 875 | 40 |

**Same Data and Expectancy According to Chart**

Area of 9,500,000 sq. ft. equals a square 3080 ft. on a side
Average radial error is 1200 ft.
Cep is therefore 1200 x 0.939 or 1130 ft.
Enter Chart with 3080 and 1130 and read expectancy as 23 per cent

Similarly:

5,700,000 equals 2400²
875 x 0.939 equals 820
Expectancy read from chart is 38 per cent

Expectancy of 23 per cent and 38 per cent given by the chart agrees satisfactorily with the actual results of 24 per cent and 40 per cent.

*See Air Forces Manual No. 67 *How to Improve Formation Bombing* for a detailed discussion of this chart.



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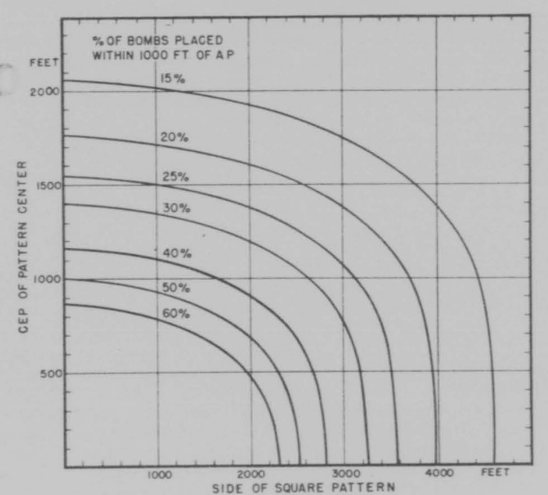
## Chart 2 Formation Bombing Chart




1. Chart shows average per cent of bombs falling within 1000 feet of AP, given size of pattern and aiming error of pattern center.
2. For patterns not square in shape use side of square of equal area.
3. The same curves and attached percentages apply for the per cent of bombs placed within 500 feet of AP if the figures on both the vertical axis and the horizontal axis are divided by 2.
4. Given the per cent of bombs falling within a circle of given radius about the AP, the per cent expected in a circle of twice this radius is shown below:
   Per cent falling within 500 feet of AP: 15 20 25 30 40 50 60
   Corresponding per cent falling within 1000 ft.: 48 59 68 76 87 94 97



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## SINGLE-HIT CHART 3

**The Single-Hit Chart** is for use with very small targets which may be destroyed by a single hit but which are to be attacked by formations. The chance of obtaining at least one hit depends jointly on (a) the chance of aiming a pattern so that it overlaps the target, and (b) the chance that one or more bombs in the pattern will hit the target. The product of these two probabilities is the chance of a single hit. Since the chance of probability (b) depends on the number of bombs in the pattern, curves are drawn for various numbers of bombs.

**Method of Use:** Enter the chart with the quotient of side of square equivalent to target area divided by side of square equivalent to pattern area and read up to the appropriate curve for the number of bombs in the pattern. Mark this point on the vertical scale **A** at the left of the chart. Connect this mark with a straight edge with a point on vertical scale **B** at the extreme right of the page which corresponds to the quotient of the side of square equivalent in area to the pattern divided by the average radial error. The point at which the straight edge cuts the central vertical scale **C** gives directly the chance of at least one hit. The Task Force Probability Table converts the probability of a single hit with one formation to the probability for two or more formations.

**Example:**

| | |
|---|---|
| **Target dimensions:** | **40 by 90 feet** |
| **Pattern dimensions:** | **1800 by 2200 feet** |
| **Bombs in pattern:** | **200** |
| **Average radial error of pattern center:** | **1000 feet** |

$40 \times 90 = 3600 = 60^2$ (side of equivalent square target)
$1800 \times 2200 =$ approx. $2000^2$ (side of equivalent square pattern)

$$\frac{\text{Side of target}}{\text{Side of pattern}} = \frac{60}{2000} = 0.03$$

$$\frac{\text{Side of pattern}}{\text{Ave. radial error}} = \frac{2000}{1000} = 2.00$$

Enter chart with the values 0.03 and 2.0 and read 10% as the chance of at least one hit when the target is to be attacked by one formation making a normal aiming. If six formations are to attack the target, the Task Force Probability Table converts the 10% to a 47% probability of success.



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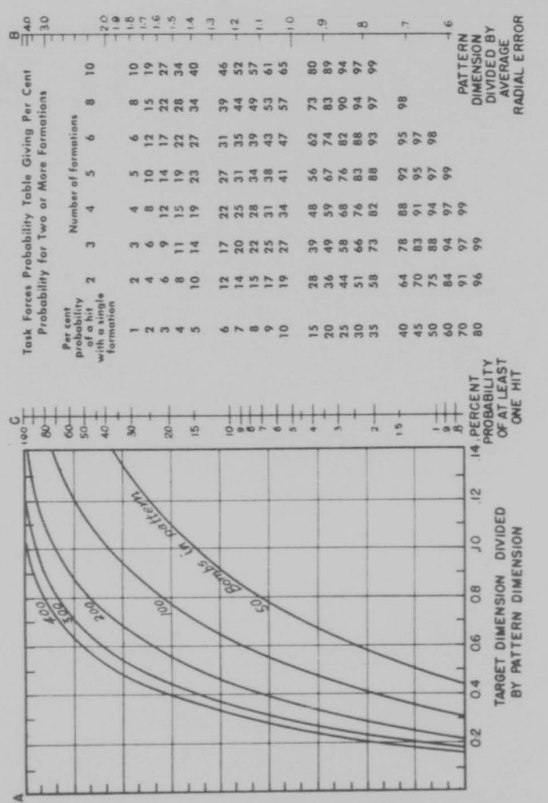
## Chart 3 — Single-Hit Chart



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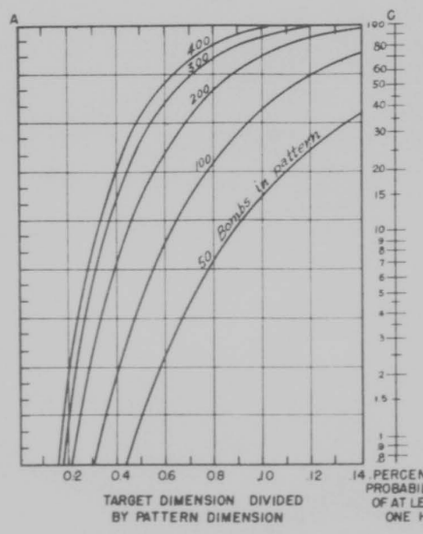


Task Forces Probability Table Giving Per Cent Probability for Two or More Formations

| Per cent probability of a hit with a single formation | Number of formations 2 | 3 | 4 | 5 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 |
| 2 | 4 | 6 | 8 | 10 | 12 | 15 | 19 |
| 3 | 6 | 9 | 12 | 14 | 17 | 22 | 27 |
| 4 | 8 | 11 | 15 | 19 | 22 | 28 | 34 |
| 5 | 10 | 14 | 19 | 23 | 27 | 34 | 40 |
| 6 | 12 | 17 | 22 | 27 | 31 | 39 | 46 |
| 7 | 14 | 20 | 25 | 31 | 35 | 44 | 52 |
| 8 | 15 | 22 | 28 | 34 | 39 | 49 | 57 |
| 9 | 17 | 25 | 31 | 38 | 43 | 53 | 61 |
| 10 | 19 | 27 | 34 | 41 | 47 | 57 | 65 |
| 15 | 28 | 39 | 48 | 56 | 62 | 73 | 80 |
| 20 | 36 | 49 | 59 | 67 | 74 | 83 | 89 |
| 25 | 44 | 58 | 68 | 76 | 82 | 90 | 94 |
| 30 | 51 | 66 | 76 | 83 | 88 | 94 | 97 |
| 35 | 58 | 73 | 82 | 88 | 93 | 97 | 99 |
| 40 | 64 | 78 | 88 | 92 | 95 | 98 | |
| 45 | 70 | 83 | 91 | 95 | 97 | | |
| 50 | 75 | 88 | 94 | 97 | 98 | | |
| 60 | 84 | 94 | 97 | 99 | | | |
| 70 | 91 | 97 | 99 | | | | |
| 80 | 96 | 99 | | | | | |

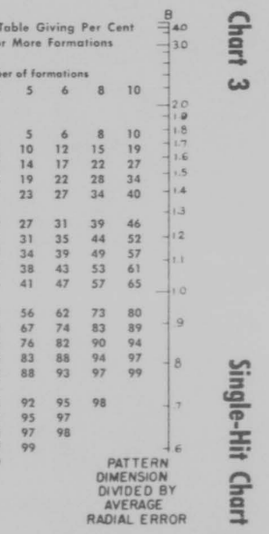


**Chart 3 Single-Hit Chart**

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## PATTERN EFFICIENCY CHART 4

**The Pattern Efficiency Chart** is designed to show the comparative efficiency of various sizes of patterns. By referring to Chart 1 it will be found that for a square target 2.0 times the average radial error in dimension about 62 per cent of bombs individually aimed (curve **0**) may be expected to reach the target area; but if patterns as large as twice the average aiming error are employed (curve **2**), about 46 per cent may be expected to reach the target. The relative efficiency, is therefore, about 46/62 x 100 per cent or approximately 75 per cent. This result may be read immediately from curve **2** on the efficiency chart, which has been prepared so that such comparisons may be made directly and conveniently.

**The efficiency of small patterns,** it will be noticed, is good for pin point targets, being about 88 per cent for a pattern equal in dimension to the average radial error. But efficiency falls off rapidly as the pattern gets larger, although with an increase in the size of the target, the relative efficiency of all sizes of patterns rapidly increases. For targets five times as large in dimension as the average radial error even very large patterns are 90 per cent efficient. For pin point targets, however, if the pattern dimension is brought down by using a small formation to approximately the average radial error, efficiency is such that the theoretical gain which might be had by attacking with individual aircraft is shown by the chart to be very small. It is assumed that the average aiming error of all the crews of the individual aircraft is the same as that of the lead crew of the formation. And while it is more difficult to aim a formation pattern than the bombs from a single airplane, this difficulty is offset by the opportunity to make use of the superior skill of the best crew as the lead crew of the formation to aim all the bombs.



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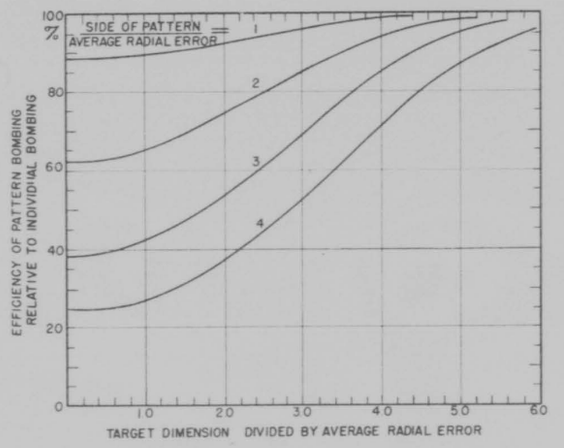
**Chart 4** **Pattern Efficiency Chart**





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## CONVERSION CHART 5

**The Conversion Chart** permits the ready conversion of a Cep, a frequently employed method of expressing the bombing accuracy of individual attacks, to estimates of the per cent of bombs which may be expected to fall within circles of 1000 feet and 2000 feet radius around the aiming point. The chart gives such estimates directly.

**Example:** A number of radar sightings are made and half the bombs dropped are reported to fall in a circle of 3000 feet radius around the aiming point. The chart gives the per cents of hits to be expected in circles of 1000 and 2000 feet radius as approximately 7 per cent and 16 per cent respectively.

**The Cep** is equal to 0.939 times the average radial error. For convenience in conversion a scale reading in terms of the average radial error has been drawn below the Cep scale. The chart may then be entered with an average radial error of 3200, for example, without conversion to the corresponding Cep of about 3000 feet.



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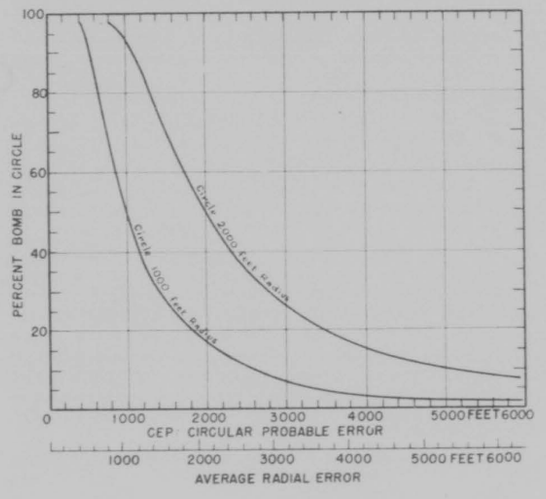
**Chart 5** **Conversion Chart**





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## PATTERN DISPERSION CHART 6

**The Pattern Dispersion Chart** is included because it reveals graphically the additional dispersion of the bombs brought about by the use of bomb patterns as laid down by formations. The chart shows that the radius of the circle containing one half of the bombs dropped may be very much larger than the radius of the circle containing one half of the pattern centers.

**Method of use:** The numbers of the lines on the graph are factors identifying pattern size. They are obtained by dividing the side of a square pattern of equivalent area to the actual area of the pattern by average radial error.

**Example:** A number of bomb patterns averaging 4200 feet square have been aimed at a common aiming point. One half the pattern centers lie with 2000 feet of the aiming point, making the Cep of the aiming operation 2000 feet. By reading from the graph line marked **2** (since the pattern dimension 4200 is about twice the average radial aiming error 2130) it may be read directly that a circle about 2500 feet in radius will be required to contain one half of the bombs dropped. Similarly, if the patterns had been 6400 feet square, and the aiming error had been the same, graph line **3** (pattern size about 3 times aiming error) would show that the larger pattern, even with the same aiming error, has dispersed the bombs so that the radius of a circle which will contain one half the bombs would have to be 3000 feet.

**This example shows,** at least for large bomb patterns, that the radius of the circle containing one half of the bombs is not solely the responsibility of the bombardiers performing the sighting operations.



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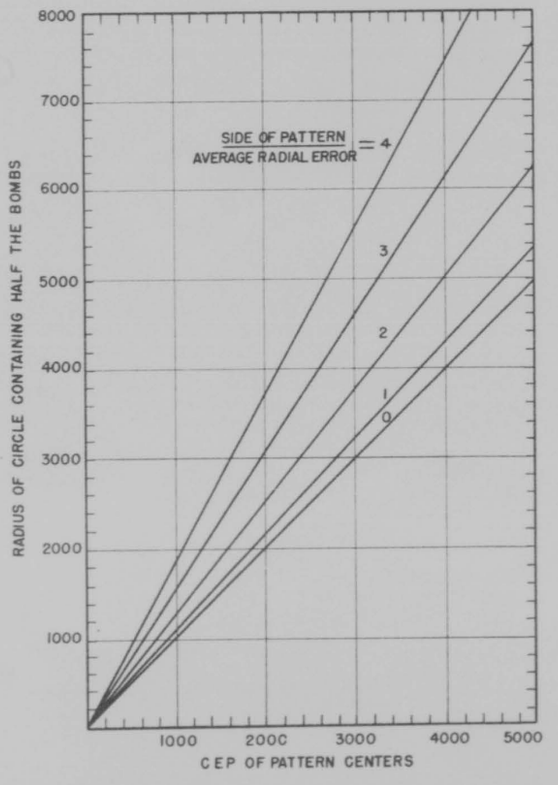
Chart 6 **Pattern Dispersion Chart**



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## EVIDENCE IN SUPPORT OF BASIC ASSUMPTIONS

**To test the predictions made** by the Formation Bombing Chart (Chart 2), a considerable body of data is available, since pattern sizes, average radial aiming error, and per cent of bombs within 1000 feet of the aiming point have been recorded for various altitudes and formation sizes. Seven examples are listed below.* Rows 8 and 9 of the table show the data properly converted for entering the chart and row 10 shows the value read from the chart. Although the averages are based upon relatively few cases, the estimates taken from the chart (see row 10) are in very good agreement with the percentages within 1000 feet taken from the bomb plots (see row 7).

**Combat Data**

| Row | Example | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | Size of Formation | 18 | 18 | 18 | 18 | 18 | 18 | 6, 7 |
| 2 | Average Altitude | 14000 | 20000 | 14000 | 20000 | 24000 | 24000 | 13000 |
| 3 | Number of patterns | 14 | 14 | 16 | 20 | 18 | 13 | — |
| 4 | Average pattern length (ft) | 1800 | 1800 | 2600 | 2600 | 2600 | 4000 | 1550 |
| 5 | Average pattern width (ft) | 1700 | 1700 | 2300 | 2300 | 2300 | 3000 | 900 |
| 6 | Average radial error | 580 | 670 | 670 | 960 | 980 | 1500 | 845 |
| 7 | Average per cent within 1000 feet | 63 | 58 | 44 | 34 | 33 | 17 | 60 |

**Computed Data**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8 | Side of equal square | 1750 | 1750 | 2450 | 2450 | 2450 | 3500 | 1180 |
| 9 | Cep of pattern center | 550 | 630 | 630 | 900 | 920 | 1400 | 800 |
| 10 | Per cent within 1000 feet | 62 | 58 | 43 | 35 | 34 | 17 | 58 |

*See report on Bombing Accuracy, 1 October 1943 to 1 March 1944, Operations Analysis Section, VIII Bomber Command Report, 12 April 1944.



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## CONVERTING AREAS TO EQUIVALENT SQUARES

**The necessity for converting rectangular areas** to squares of equivalent area will frequently arise in the course of using the charts in this manual. Suppose a target is 1700 by 3300 feet. What is the side of the square of equal area? The answer requires taking the square root of the product of 1700 x 3300. To facilitate this step a Table of Squares is given below, which is used as follows: The product of 17 and 33 equals 561. The nearest number to 561 in the body of the table is 576, which is the square of 24. The square root of 561, to the nearest whole number, is therefore 24, and the desired result is 2400 to the nearest hundred, which is sufficiently accurate for the use of these charts.

**Similarly in using Chart 1** for targets long in proportion to their width it is necessary to take the square root of the product of two percentages. Thus, if the two percentages are 77 and 18, the product is 1386. The nearest number to 1386 in the table is 1369, which is the square of 37. Thirty-seven, therefore, is the square root to the nearest whole number.

**Table of Squares**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 4 | 9 | 16 | 25 | 36 | 49 | 64 | 81 |
| 1 | 100 | 121 | 144 | 169 | 196 | 225 | 256 | 289 | 324 | 361 |
| 2 | 400 | 441 | 484 | 529 | 576 | 625 | 676 | 729 | 784 | 841 |
| 3 | 900 | 961 | 1024 | 1089 | 1156 | 1225 | 1296 | 1369 | 1444 | 1521 |
| 4 | 1600 | 1681 | 1764 | 1849 | 1936 | 2025 | 2116 | 2209 | 2304 | 2401 |
| 5 | 2500 | 2601 | 2704 | 2809 | 2916 | 3025 | 3136 | 3249 | 3364 | 3481 |
| 6 | 3600 | 3721 | 3844 | 3969 | 4096 | 4225 | 4356 | 4489 | 4624 | 4761 |
| 7 | 4900 | 5041 | 5184 | 5329 | 5476 | 5625 | 5776 | 5929 | 6084 | 6241 |
| 8 | 6400 | 6561 | 6724 | 6889 | 7056 | 7225 | 7396 | 7569 | 7744 | 7921 |
| 9 | 8100 | 8281 | 8464 | 8649 | 8836 | 9025 | 9216 | 9409 | 9604 | 9801 |

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# HOW TO IMPROVE FORMATION BOMBING

APRIL 1945

AIR FORCES MANUAL No. 67

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# HOW TO IMPROVE FORMATION BOMBING

## AIR FORCES MANUAL No. 67

Pattern Size as a Factor in Formation Bombing

Uses for the Formation Bombing Chart

Characteristics of Small and Large Bomb Patterns

Recording Pattern Dimensions and Aiming Errors

Reduction of Pattern Size and Aiming Errors

Perspective

Published by

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Washington, 2 April 1945

Air Forces Manual No. 67 "How to Improve Formation Bombing" is published for the information and guidance of all concerned.

BY COMMAND OF GENERAL ARNOLD:

BARNEY M. GILES
Lieutenant General, United States Army
Deputy Commander, Army Air Forces

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## INTRODUCTORY SUMMARY

Most of the bombs dropped by the United States Army Air Forces in this war have been dropped from formations ranging in size from three to twenty or more aircraft. Consequently there is a real need for consideration of factors which affect the results of formation bombing.

It is intended to present here a simple statement of the inter-relation of pattern size and aiming error and how they affect the percentage of bombs dropped by a formation which actually strike the target. If the commanding officers of bombardment units understand the relationships between pattern size and aiming error, they will find them of material assistance in evaluating the performance of their commands and taking the necessary steps to improve their bombing accuracy. Moreover, an understanding of these relationships is indispensable for the estimation of force requirements and for the preparation of a time schedule for a strategic bombardment program.

To this end has been prepared the simple Formation Bombing Chart shown in figure 1, which has the following uses:

**a.** The chart immediately reveals the improvement in the per cent of bombs placed within 1000 feet of the aiming point* which will result from (a) a reduction in the size of the bomb pattern, (b) a reduction in the aiming error of the bomb pattern, (c) any combination of these two factors. Accordingly the efforts of a bombardment group may be applied to the reduction which will bring about the greatest improvement in its bombing.

**b.** The unit commander may plot periodically on the chart the aiming error and the size of the bomb patterns made by his formations and ascertain whether or not the bombing technique is improving. Comparison may easily be made of the relative progress of two or more air forces, bomber commands, combat wings, or groups.

*Throughout the following discussion "aiming point" should be taken to mean the center of the target.





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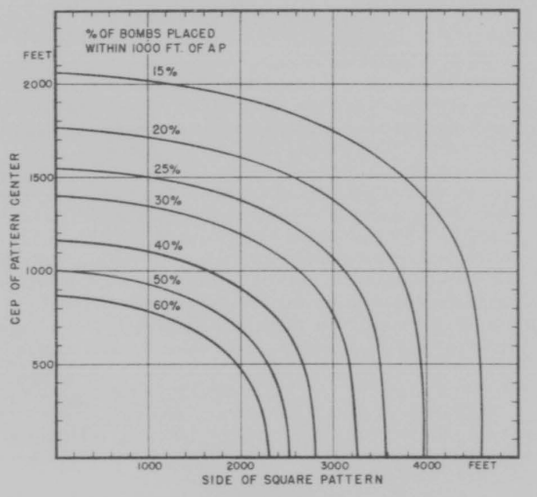


1. Chart shows average per cent of bombs falling within 1000 feet of AP, given size of pattern and aiming error of pattern center.
2. For patterns not square in shape use side of square of equal area.
3. The same curves and attached percentages apply for the per cent of bombs placed within 500 feet of AP if the figures on both the vertical axis and the horizontal axis are divided by 2.
4. Given the per cent of bombs falling within a circle of given radius about the AP, the per cent expected in a circle of twice this radius is shown below:
   Per cent falling within 500 feet of AP: 15 20 25 30 40 50 60
   Corresponding per cent falling within 1000 ft.: 48 59 68 76 87 94 97

*Figure 1. The Formation Bombing Chart*

**c.** As the chart indicates the per cent of bombs falling within 1000 feet of the aiming point for any average pattern size and aiming error, it may be used to gauge the



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relative bombing efficiency of formations of various numbers and arrangements of aircraft.

**d.** The chart may be used to forecast the effect of altitude on the per cent of bombs falling within 1000 feet of the aiming point if the effect of altitude on pattern size and aiming error is known.

Uses of the Formation Bombing Chart will be clarified by the following pages, and some measures will be listed which may be taken to improve formation bombing accuracy. The statements offered in those pages, however, must be taken by the reader as directed only at improving the accuracy of formation bombing. The percentage of hits on a given area, the 1000-foot circle referred to herein for example, cannot be considered a measurement of the effectiveness of bombing when "effectiveness" is interpreted to mean the damage resulting from a given number of hits in such an area.

## Section I

## PATTERN SIZE AS A FACTOR IN FORMATION BOMBING

To represent the accuracy of bombing from formation, another variable not present with individually aimed and released bombs must be reckoned with. For a series of individually aimed bombs the circular probable error suffices to give a usable picture of the accuracy of the bombing. Given the Cep, the distance from the aiming point within which half of the bombs fall, it is simple to determine the per cent of bombs falling within any other specified distance from the aiming point. For individually aimed bombs the Cep is therefore a convenient and adequate measure of accuracy, and accuracy of aiming is the sole consideration with such bombs. The additional variable which must be considered with formation bombing is the size of the bomb pattern.

This variable arises because formation bombing which places any specific percentage of bombs within a 1000-foot circle around the aiming point may attain that percentage



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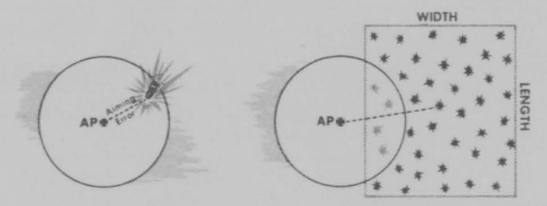


For individually aimed bombs the aiming error (Cep) is sufficient to describe the bombing.

For formation bombing the aiming error of the pattern center and the dimensions of the pattern are required.

*Figure 2. Describing pattern bombing*

by various combinations of pattern size and accuracy of aiming the pattern. The possibility of such combinations becomes apparent from a consideration of two extreme cases, both resulting in placing, say, 50 per cent of the bombs within 1000 feet of the aiming point.

**Case 1.** At one extreme lies the case where the pattern size approaches the dimensions of a single bomb. The circumstances of this case are identical with those which hold for singly aimed and released bombs. Accuracy of aiming alone determines the result, the Cep of the aimings being 1000 feet because one half of the bombs are within 1000 feet.

**Case 2.** At the other extreme is the case where the aiming error approaches zero. Here the pattern will be superimposed over the 1000-foot circle around the aiming point, and the per cent of bombs falling within the circle will be determined solely by the size of the pattern. If for theoretical purposes a uniform distribution of bombs within the pattern is assumed, half of the bombs dropped will strike within the circle when the area of the pattern is twice the area of the circle.*

*Combat bomb patterns rarely show a uniform distribution of bombs. Patterns normally thin out toward their edges. The consequent effect is to make the pattern equivalent to a smaller pattern in which the bombs are equally distributed. For this reason the chart in figure 1 tends to underestimate the per cent of bombs placed by the normal pattern within 1000 feet of the aiming point, as the curves of necessity are based on assumed equal distribution within patterns.



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In between these cases of the extremes are combinations of pattern size and aiming error which will result, on the average, in placing 50 per cent of the bombs within 1000 feet of the aiming point. Figure 3 shows three examples. The Formation Bombing Chart (figure 1) shows all such combinations by means of the curve marked 50%. Similar curves on the chart indicate combinations which place 60,

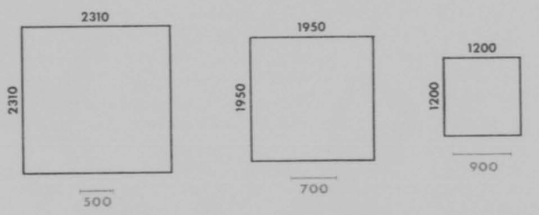


***Figure 3. Examples of combinations of pattern size and average aiming error which, on the average, will place 50 per cent of the bombs within 1000 feet of the aiming point.***

40, 30, 25, 20, and 15 per cent of the bombs within 1000 feet of the aiming point. If a bombardment unit knows the average size of its patterns and the average aiming error of its pattern centers, it can locate itself on the chart and read from the curves the per cent of the bombs it will place within 1000 feet of the aiming point. Pattern size is plotted as the size of a square equal in area to the bombing pattern.*

The aiming error is plotted as the Cep of the pattern centers, i.e., 0.939 times the average distance of the pattern center from the aiming point.**

*Although bomb patterns are usually irregular in outline, the error, for the patterns encountered in operations, of using a square of area equivalent to the area of the pattern, seems to be unimportant in these computations.
**See TM1-251, "Handbook for Bombardiers."



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## Section II

## USES FOR THE FORMATION BOMBING CHART

**1. To discover the profitable course for improvement.** The Formation Bombing Chart can be extremely useful in that it points out the most profitable steps for a bombing unit to take to improve its bombing, once it has oriented itself on the chart. Suppose that the bombing unit has an aiming error of 1100 feet and a pattern area equal to $3600^2$. It locates itself on the chart as shown in figure 4 at point A, near the 20 per cent curve. To progress to the 25 per cent curve, i.e., to attain 25 per cent bombing, the unit would have to reduce its bombing error substantially to zero (point C) if it did not change its pattern size. Yet quite a moderate reduction in pattern size to $3000^2$ (point B) will achieve the transition to the 25 per cent curve with no improvement whatever in the aiming of the pattern. It is apparent that for unit locations along the vertical part of curve a much smaller reduction of the pattern dimension than the reduction which would be required in the aiming error will bring about progress to a curve of higher percentage. But, if the pattern size and aiming error of a unit place it along the horizontal part of a curve, a reduction in the aiming error is indicated as the more feasible goal for its efforts to improve.

The Formation Bombing Chart serves therefore as a guide to operating units in that it shows them where to place the emphasis in their attempts to raise their bombing efficiency. Furthermore it enables them to estimate the amount of improvement in pattern size or aiming, or in both, which will be necessary to attain whatever goal is set.

**2. To plot performance.** A bombing unit may plot its performance from time to time on the Formation Bombing Chart as to pattern size and accuracy of aiming the pattern. The performance of the Eighth Air Force, for example, has been charted as points A through G on figure 5, which represent outstanding steps in its progress in bombing accuracy. The marked reduction in the size of the pattern which was brought about by the adoption of the



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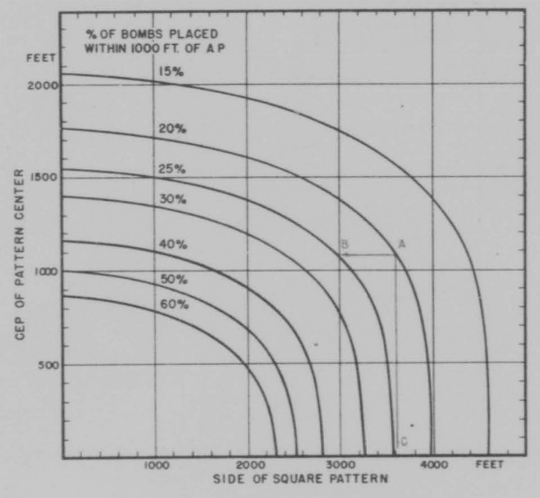


***Figure 4. The Formation Bombing Chart diagnoses bombing illness and prescribes a cure.***

practice of dropping on a leader—after an initial period during which bombardiers of all aircraft sighted individually for range—and the use of minimum intervalometer or salvo releases was a very large factor in causing the great improvement in the per cent of bombs falling within 1000 feet of the aiming point. Part of the reduction in aiming error came automatically with a reduction in pattern size. A smaller pattern is easier to aim because the bombs of the lead airplane assume a definite position in the pattern, and as a result the lead bombardier is able to make the proper allowance in his sighting and dropping to center the pattern as a whole on the target.



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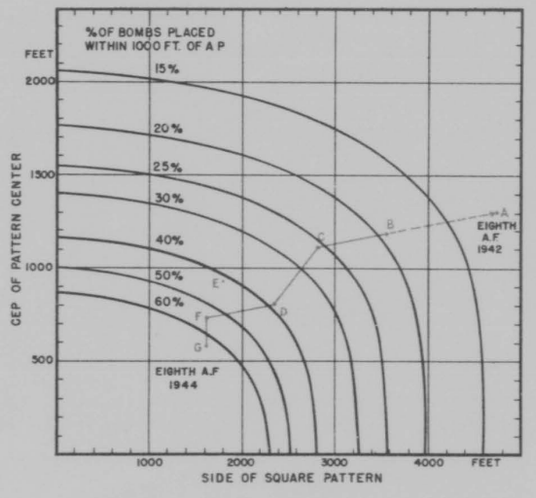


*Figure 5. Progress of Eighth Air Force Bombing*

**3. To determine the effect of change in altitude on a given instance of formation bombing.** The effect of change in altitude on formation bombing is sharply brought out by the Formation Bombing Chart it use is made of certain observations and assumptions of the effect of altitude on pattern size and aiming error. In the European Theater it was found that each additional 1000 feet of altitude added 60 feet to the length and 60 feet to the width of the pattern. If, then, the average pattern size and aiming error for 20,000 feet is taken as a starting point, the following table can be constructed with the aid of the chart, assuming a constant mil error, to predict the effect on accuracy of bombing



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| Point (See Chart) | Time | Pattern Size Length | Width | Cep of Pattern Center | Average % of Bombs in 500' | 1000' | Comment |
|---|---|---|---|---|---|---|---|
| A | 1942 | Over 1 Mi long | | — | | | (no reliable records) |
| B | 1943[a] | 4,600 | 2,600 | 1,180 | | | Individual sightings for range |
| C | 1943[a] | 3,200 | 2,500 | 1,130 | | 24.6% | Dropped on leader |
| D | 1 Oct 1943 – 1 Mar 1944[b] | 2,600 | 2,200 | 820 | | 37% | Minimum intervalometer; some salvo |
| E | 1944[c] | 1,900 | 1,900 | 940 | 15% | | Minimum intervalometer |
| F | 1944[c] | 1,700 | 1,700 | 740 | 24% | | Salvo |
| G | 1944[c] | 1,750 | 1,700 | 600 | 25% | | 12-14 A/C formation |

[a] See Analysis of VIII Bomber Command Operations from the point of view of Bombing Accuracy, Operations Analysis Section Report, 31 October 1943.

[b] See Report On Bombing Accuracy, 1 October 1943 to 1 March 1944, Operations Analysis Section, VIII Bomber Command Report, 12 April 1944.

[c] See Memorandum on Salvo and Intervalometer Releases, Operations Analysis Report, Eighth Air Force, 16 September 1944. Data for points E, F, G are for patterns in the altitude bracket 18,000—22,500 using 500 lb. bombs from B-17 A/C. Point E is not included in the line on the chart showing the progress of the Eighth Air Force because the data for this point is based on patterns dropped over an earlier period of time. They were segregated to show a comparison between salvo and intervalometer releases. Except for point G the data refer to patterns made by combat boxes of 18-21 A/C.

**Many other factors than those included contributed to the continuous improvement in the bombing over the period of time examined here: maps developed to facilitate identification of the target, improvement in training, and the accumulated experience of the operating groups—to mention a few.**

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should the formation be ordered to bomb at a different altitude.

| Altitude | Side of Square Pattern | Aiming Error of Pattern | Percent within 1,000 Ft. of AP From Formation Bombing Chart | From 8th AF Experience* |
|---|---|---|---|---|
| 15,000 | 1,700 | 690 | 55% | 50% |
| 20,000 | 2,000 | 920 | 40% | 40% |
| 25,000 | 2,300 | 1,150 | 29% | 27% |
| 30,000 | 2,600 | 1,380 | 22% | |
| 35,000 | 2,900 | 1,610 | 17% | |

*Data taken from an altitude-accuracy curve prepared in March, 1944.



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**4. To estimate relative bombing accuracy of projected formations.** The relative bombing efficiency of a contemplated formation may be estimated by means of the Formation Bombing Chart by entering the expected size of bomb pattern for the formation. If the same aiming error is assumed for patterns being compared, the chart will indicate the per cent of bombs from each pattern which it may be expected will fall within 1900 feet of the aiming point.

## Section III

## CHARACTERISTICS OF SMALL AND LARGE BOMB PATTERNS

The Formation Bombing Chart (figure 1) indicates that for the same aiming error small bomb patterns will place a greater percentage of their bombs within 1000 feet of the aiming point than large patterns. This indication is thoroughly borne out by experience in the European Theater, as is shown by the following table taken from an operations analysis report.*

**Classification of Bomb Patterns by Area**

| Area in Million Square Feet | Average per cent of Bombs within 1000 ft. of AP |
|---|---|
| 3 or less | 60% |
| 3¼ - 5 | 40% |
| 5¼ - 7 | 35% |
| over 7 | 27% |

Despite the fact that in some instances in which a small bomb pattern would completely miss the target circle a large pattern with the same aiming error would overlap the target to place some bombs on it, the advantage lies in

*See Report on Bombing Accuracy, 1 October 1943 to 1 March 1944, Operations Analysis Section, VIII Bomber Command Report, 12 April 1944. This, and other Operations Analysis Reports, may be obtained from the Operations Analysis Division, Headquarters Army Air Forces.



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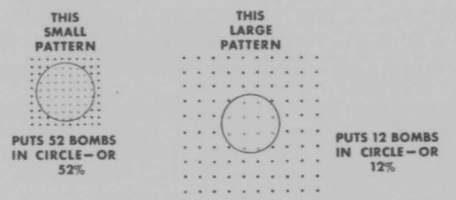


*Figure 6. Small patterns vs. large patterns*

the long run with the small pattern. Because it is large, the large pattern can never get a large proportion of its bombs close to an assigned pin point. The small pattern can get a large proportion of its bombs there and does get them there often enough to more than make up for the complete misses which may be registered with the small pattern. Targets are also customarily attacked by several formations, so that it is not material if on occasion a small pattern misses completely, since it is the average for the patterns of all the formations by which the mission is appraised. It is the outcome of the aggregate performance of all the task force—the team of formations—sent over the target which adds up to make a day's work.

The remainder of this section presents a fuller discussion of the characteristics of small and large patterns. It will repay close attention, as an understanding of what is set down in it is essential to a realistic conception of pattern bombing.

What has been said up to this point has been chiefly concerned with the average per cent of bombs falling within 1000 feet of the aiming point as a result of various combinations of pattern size and aiming error. This average may conceal a very important characteristic of pattern bombing. Unit commanders who fail to perceive it have often been led deliberately to make large patterns.

At first thought the risk that a small pattern may completely miss the target might lead to the conclusion that a



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larger pattern with the same aiming error would be preferable because it would place at least some bombs on the target. This contention can best be examined by breaking down the average per cent to tabulate the frequency with which the various individual percentages within 1000 feet of the aiming point actually occur. For such an examination two patterns may be chosen: (a) a small pattern equal in area to the 1000-foot circle around the aiming point, and (b) a large pattern of four times the area of the small pattern. For each pattern a Cep of 1000 feet for aiming will be assumed. It is evident that in many instances the small pattern will get nearly all its bombs in the 1000-foot circle around the aiming point. But it is impossible for the large pattern to get more than 25 per cent of its bombs in the circle because it is four times as large in area as the circle. This is the fact which may be concealed if averages alone are considered and which may be overlooked in dwelling on the danger of missing completely with the small pattern. If the concern is with targets which require many hits and which will be attacked by several formations, it is not the number of formations which miss completely that matters so much as the final percentage of hits for all the attacking formations. The table and figure 7 give a clarifying breakdown.

**Cep of Pattern Centers = 1,000 Feet for Both Patterns**

| (a) Small Pattern Area = Area of Circle 1,000' Radius | | (b) Large Pattern Area = 4 Times Area of Circle 1,000' Radius | |
|---|---|---|---|
| Per Cent of Bombs within 1,000 Feet of AP | Number of Patterns Giving this Per Cent | Per Cent of Bombs within 1,000 Feet of AP | Number of Patterns Giving this Per Cent |
| 80-100 | 7 | 25 | 50 |
| 60- 80 | 18 | 20-25 | 27 |
| 40- 60 | 25 | 15-20 | 11 |
| 20- 40 | 23 | 10-15 | 7 |
| 0- 20 | 21 | 5-10 | 4 |
| 0 | 6 | 0- 5 | 1 |
| Total No. Patterns | 100 | | 100 |
| Average per cent within 1,000 feet of AP: 40% | | Average per cent within 1,000 feet of AP: 22% | |



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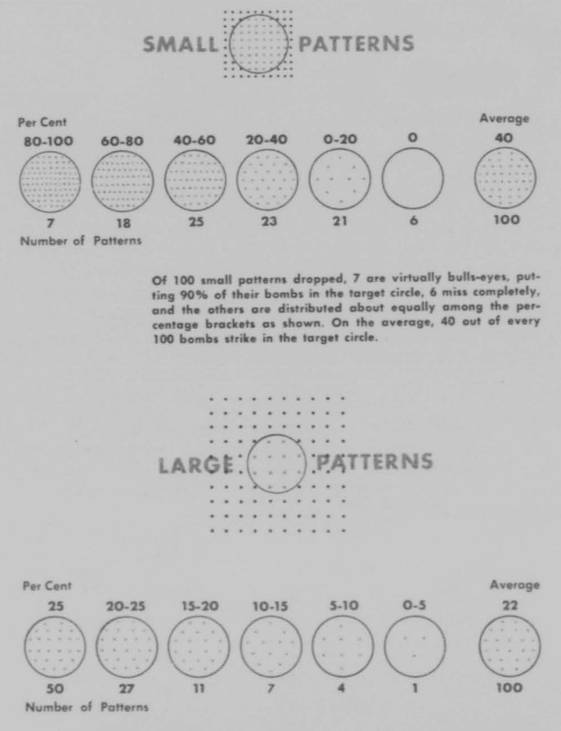


Of 100 small patterns dropped, 7 are virtually bulls-eyes, putting 90% of their bombs in the target circle, 6 miss completely, and the others are distributed about equally among the percentage brackets as shown. On the average, 40 out of every 100 bombs strike in the target circle.

Of 100 large patterns dropped, half put 25% of their bombs in the target circle and none miss entirely. But on the average, only 22 out of every 100 bombs strike in the target circle.

*Figure 7. Small patterns vs. large patterns—probabilities.*



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The table reveals that 6 out of 100 of the small patterns may be expected to miss completely, while only one out of 100 large patterns may be expected to place fewer than 5 per cent of its bombs within the 1000-foot circle. There is not only this apparent advantage for the large pattern of minimizing the possibility of complete misses, but another apparent advantage in that 77 out of 100, or over three quarters, of such patterns can be expected to place 20 to 25 per cent of their bombs in the 1000-foot circle, so that very high assurance is given a single attack. But these advantages disappear if more than one attack is considered. A comparison of the average per cents for the two types of patterns discloses that the small pattern places nearly twice the percentage of the large pattern within the target circle. This is a comparison important for commanders to remember. It means that a pattern which may miss the target more often than another pattern may yet make for better bombing.

Formation bombing necessarily yields results fluctuating more widely than those of attacks by single aircraft because the technique affords a smaller number of aimings. That the fluctuations can be predicted, however, is demonstrated by comparison of results which could be predicted for 100 consecutive normal aimings of Eighth Air Force patterns dropped early in 1944 with the actual results.

| Per Cent of Bombs within 500 Feet of Aiming Point | 100 Eighth Air Force Patterns | Predicted Results with Pattern 1,800 Feet Square Cep Equals 875 Feet |
|---|---|---|
| over 25% | 24 | 20 |
| 20-25% | 12 | 17 |
| 15-20% | 14 | 13 |
| 10-15% | 13 | 12 |
| 5-10% | 16 | 11 |
| 0- 5% | 10 | 13 |
| 0% | 11 | 14 |
| | 100 | 100 |

The variation in result from none to a very high percentage of bombs within 1000 feet of the aiming point is largely overcome if several formations are sent over the target. Attack by even as few as four formations greatly stabilizes results, as is shown by the following table.



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One die is cast

all throws from 1 to 6 are equally probable.

Four dice

are cast

throws cluster around 14—values as low as 4 or as high as 24 come up seldom.

Four formations go over the target. Results average 42 per cent strikes in the target circle. Four patterns missing or four scoring in the top bracket are unlikely.

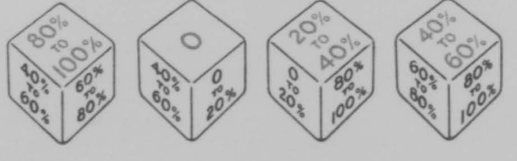


*Figure 8. Bet on averages*



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**Small Pattern: Area = Area of 1,000-Foot Radius Circle**
**Cep of Pattern Center = 1,000 Feet**

| Per Cent of Bombs within 1,000 Feet of Aiming Point | Distribution of 100 Single Patterns | Distribution of 100 Averages of 4 Patterns |
|---|---|---|
| 80-100 | 7 | — |
| 60- 80 | 18 | 7 |
| 40- 60 | 25 | 42 |
| 20- 40 | 23 | 44 |
| 0- 20 | 21 | 7 |
| 0 | 6 | — |
| | 100 | 100 |

The table discloses the stabilization of the composite result of as few as four formations attacking a target since the percentage of bombs hitting within the target circle ranges between 20 and 60 per cent for 86 per cent, or 6 out of 7, of the targets attacked. Although this range may still seem large, it is inherent to present pattern bombing.

In this connection it should be remembered that the centers of several patterns aimed independently at the same aiming point will be dispersed around it in the same manner as singly aimed bombs. The patterns will overlap one another and the target area in varying degrees. For an example it has been computed* that, on the average, for four bomb patterns, each 3000 feet square and aimed at a target 2000 feet square with a Cep of 1177 feet, the following density of coverage is attained:

**2% of the target area will be missed completely.**
**11% of the target area will be covered with 1 pattern.**
**31% of the target area will be covered with 2 patterns.**
**38% of the target area will be covered with 3 patterns.**
**18% of the target area will be covered with 4 patterns.**

Formations cannot be expected to superimpose their patterns like pancakes on a breakfast plate. In fact only a small part of the target is covered with the maximum density, and every effort to date to increase this density has not led to

*Report No. 1, Operations Analysis Section, XXI Bomber Command, 16 November 1944.



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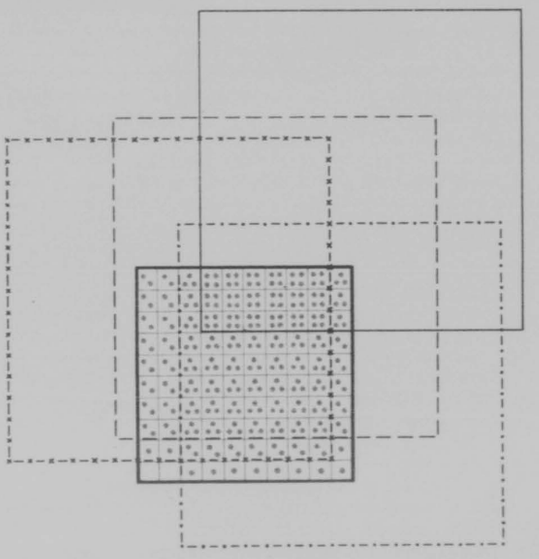
overbombing of industrial targets. Damage appraisal reports reveal that the bombing already achieved, though effective, still leaves much to be desired.



Here four patterns 3000 feet square have been aimed at a target 2000 feet square with a Cep of 1177 feet for the pattern centers. The target has been ruled into 100 squares to show graphically the approximate variation in density of coverage to be expected.

*Figure 9. Pattern coverage varies in density. Formations cannot stack up their patterns like pancakes on a plate.*



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## Section IV
## RECORDING PATTERN DIMENSIONS AND AIMING ERRORS

Records of past performance are invaluable for proper control of efforts to improve the accuracy of bombing. As has been pointed out in conjunction with the presentation of the Formation Bombing Chart, such efforts will be directed at one or both of two factors: aiming error and size of pattern. Unit records of both are required for employment of the chart.

For formation bombing care must be exercised in the method of expressing and interpreting the aiming error. Although the traditional Cep is useful as a measure of aiming accuracy for individually aimed bombs (see Section I), its inadequacy as such a measure for large-pattern formation bombing is now visible in the light of the intervening discussions. If the Cep is taken to mean the radius of the circle around the aiming point which contains half the bombs dropped, and it is normally so taken, that figure does not bear the simple relation to the skill of bombardiers aiming large patterns that it does if they aim single bombs.

Reference to the Formation Bombing Chart shows that a pattern 3700 feet square, aimed with a Cep for pattern centers of 1000 feet, places on the average only 20 per cent of its bombs within 1000 feet of the aiming point. With such a pattern it is estimated that half of the bombs will fall within 1770 feet of the aiming point, so that the Cep of the bombs may therefore be taken to be 1770 feet. By association with a similar figure for individually aimed bombs it may be thought that the bombardier's performance is poor. Actually he is performing the difficult task of aiming a very large pattern so that half of his pattern centers lie within 1000 feet of the aiming point. Measures for improvement accordingly do not derive from sharpening the aim but from a drastic reduction in the size of the pattern. Another bombardment unit may be placing 20 per cent of its bombs within 1000 feet of the aiming point with a pattern 2000 feet square but with a Cep of 1600 feet for the pattern centers. These circumstances would indicate a reduction in



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the aiming error, since now the aiming error is the main factor in producing the unit's poor bombing. Because it is relatively large and the pattern size is already relatively small, it is the obvious point of attack.

When, then, the concept of a Cep is to be applied to formation bombing, its reference should always be carefully specified: Cep of the pattern centers or Cep of the bombs. Confusion of the term is easy and obscures diametrically opposite problems.*

For use in conjunction with the Formation Bombing Chart the Cep of the pattern centers is required. The center of the pattern may be determined by any of three methods:

**a.** By inspection.

**b.** By taking the center of a circle of 500 feet (or 1000 feet) radius so placed over the pattern as to include the largest number of bombs.

**c.** By taking the intersection of a pair of lines parallel to and at right angles to track, each line to have one half of the bombs to either side.

The use of the MPI is not recommended because it is tedious to compute and because stray bombs exert an undue influence. Once the center of the pattern is determined the radial distance to the aiming point is recorded. The average of these distances multiplied by 0.939 gives the Cep of the pattern centers (see "Handbook for Bombardiers").

The size of the bomb pattern may be taken as the dimensions of a rectangle (one edge parallel to track) which substantially encloses the bomb fall. Obvious stray bombs, including an early or late release from one of the aircraft in the formation, are disregarded.

A detailed account of the procedures for making these measurements and of the technique for making bomb plots of individual patterns from the strike photographs is available in an Operations Analysis Memorandum.**

*As a matter of fact, data from the theaters is now commonly expressed in terms of the per cent of the bombs dropped which fall within some simple multiple of 1000 feet of the aiming point.

**Memorandum on Methods of Analysis and Reliability of Measures Employed in the Study of Bombing Accuracy. Operations Analysis Section, Eighth Air Force.



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## Section V

## REDUCTION OF PATTERN SIZE AND AIMING ERRORS

It has been pointed out that the per cent of bombs placed within 1000 feet of the aiming point is increased (a) by diminishing the area of the bomb pattern, (b) by decreasing the average aiming error, (c) by reducing both. The Formation Bombing Chart indicates directly for any current operating performance which reduction should be emphasized. The succeeding paragraphs offer suggestions of means and ways of effecting such reductions.

**Pattern size.** The area of the pattern may be diminished by:

**a.** Maintaining a better formation on the bomb run by all pilots striving to keep their proper position in the formation and to hold exactly the same speed and exactly the same heading.

**b.** Achieving as nearly simultaneous a release as possible by all aircraft in the formation.

**c.** Employing minimum intervalometer or salvo release.

**d.** Employing Automatic Bomb Release.

**Aiming Error.** The aiming error may be decreased by:

**a.** Standardizing the bomb pattern to fix the lead bombs in a definite position with reference to the center of the pattern. A fixed location for the lead bombs on the pattern permits the lead bombardier to calculate the offset in his sighting which is required to center the bomb pattern on the target.

**b.** Making practice runs. If the lead bombardier drops large bombs, they can be identified in photographs. The position of the strike of such bombs should be adjusted in the plot for the known difference in range between them and the small practice bombs dropped by other aircraft in



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the formation. The lead bombs will then be indicated in their normal position in the bomb pattern, and the required offset can be determined.

**c.** Carefully choosing lead crews.

**d.** Employing Automatic Bomb Release.

**Teamwork.** Formation bombing requires more than teamwork by the crew members of a single aircraft. Formation bombing requires formation teamwork. Bombing results depend very greatly upon the bomb pattern not only because of the effect of the size of the pattern but because a good bomb pattern can be aimed more successfully than a poor one.

Pilots play an important part in making a good pattern. The wing bombardiers, acting on signal from the lead aircraft, merely determine when the bombs go away. It is the wing pilots who really determine where the wing bombs go. At 20,000 feet a difference of three degrees in heading from that of the lead aircraft causes a lateral displacement of the wing bombs of 600 feet by the time they reach the ground. That is why bomb patterns are often twice as wide as the dropping formation was in the air. Bombardiers did not make them wide.

Wing bombardiers can make patterns string out by not acting promptly on signal from the lead ship. The Automatic Bomb Release activated by the lead ship solves this problem.

The task of the lead bombardier is to aim the pattern at the target, a more difficult task than aiming a single bomb. Obviously he must have something definite to aim. He cannot successfully aim a ragged pattern. When a formation learns to reproduce a standard pattern, the lead bombardier can soon discover what he must do to aim the pattern. With employment of the Automatic Bomb Release the position of the lead bombs should be fixed more certainly in the pattern, and the precision of the lead bombardier's aim should increase to approach more nearly that which he can attain with single bombs.



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## Section VI

## PERSPECTIVE

In theory formation bombing can never equal in effectiveness the bombing done by individual aircraft. But the formation has been accepted (a) as an instrument for self-defense, (b) as a means of getting a large force over a target in a short interval of time, and (c) as a way to facilitate the efforts of escort fighters to protect the bombers. It is quite possible that the bombing of formations of moderate size is not appreciably less effective than that by single attack. The formation enables a unit to capitalize on the superior attainments of a lead crew, which certainly afford greater assurance that the target will be identified and the sighting operation performed with precision under adverse conditions than do those of the average crew. In addition, the bomb patterns from each formation can be identified so that faults may be detected and technique improved. Such identification is not feasible for individual attacks, and every crew viewing a composite bomb plot can believe that their own bombs are near the aiming point and those which missed were dropped by some other crew. Development of a technique of identifying bomb patterns now denies this natural tendency toward self exculpation to formation crews. And the ability to recognize good work and to test and select the most effective techniques has proved to be a very important factor in the great advances made by the Army Air Forces in bombing effectiveness.

It is obvious that the larger the percent of bombs falling within 1000 feet of the aiming point, the easier it is to accomplish a bombing objective. And if this per cent is known, it becomes possible to estimate the force required for the destruction of a given target and to determine the time necessary to complete a target program, provided that the force available and the rate of operation are also known. But there are other important factors which can greatly modify an overall perspective.



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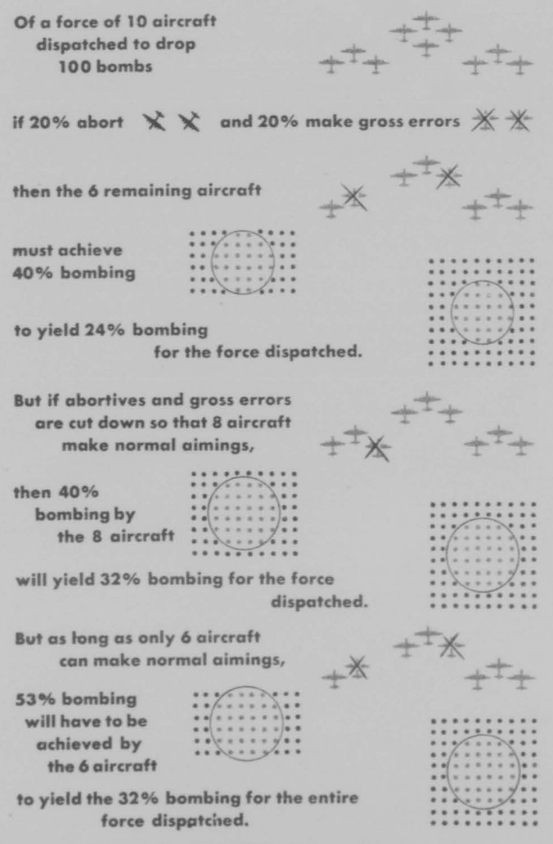


*Fig. 10. The effect of abortives and gross errors.*



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The per cent of bombs within the target circle does not, by itself, reveal very much about the total yield of the bombing effort. The final result of an operation is greatly influenced by the fractions of the force involved which fall into the abortive and gross error categories. If these fractions are reduced, as in the example illustrated, the expectancy of hits is raised. If they remain the same, the quality of bombing achieved by normal aimings must rise to increase the percentage of hits.

Various measures are required, then, to raise bombing effectiveness besides those directed at normal aimings. But it has been the purpose of these pages to consider only the factors appearing in formation bombing which determine the percentage of bombs falling from normal aimings within 1000 feet of the aiming point.*

*The discussions also apply to radar bombing done from formations.



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of
The Commanding General
Army Air Forces
11 Dec 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

11 December 1944

A NOTE FOR THE INFORMATION OF:
MAJOR F. L. MC INTYRE, TWENTIETH AIR FORCE

Subject: Suggested Answers to J. C. S. Questions.

4. (Q) WHAT IS THE ESTIMATE IN PERCENTAGE DROP IN ACCURACY OF BOMBING FROM SHIPPED VHB, AS A RESULT OF HIGHER ALTITUDE BOMBING AND HIGHER SPEED?

(A) Answer not known. One estimate, admittedly based on unsubstantiated guesses, by AC-92 personnel, suggests that an equal number of bombs will fall within 1000' of an assigned AP from a stripped VHB at over 30,000 ft. altitude carrying 20,000# and a standard B-29 at 20-25,000 carrying 5000#. Tests are now being run at Eglin Field, and at Alamagordo to verify these estimates.

13. (Q) WHAT (IF POSSIBLE TO FIGURE) IS THE ACCURACY OF BLIND BOMBING, IN PERCENT AT THIS TIME AS COMPARED TO VISUAL BOMBING?

(A) Inadequate data available from B-29 operations. Eighth Air Force experience with APQ-13 suggests average aiming error of one mile on blind bombing as compared with 1000' on day visual bombing. At present, it is believed that most strategic industrial targets should be attempted to be bombed only by visual methods, --i. e., if overcast, secondary target should be an area target. Improvement of offset methods, and general radar techniques may alter this.

17. (Q) WHAT PERCENT ACCURACY CAN BE EXPECTED IN NIGHT BOMBING AS COMPARED TO DAY VISUAL BOMBING?

(A) No experience with night bombing. Could perhaps be counted as similar to blind bombing in expected results. Perhaps worse if individual aimings rather than formation patterns are used. Perhaps better if good target indicator techniques are developed.

21. (Q) IS IT SOUND LOGIC TO ASSUME THAT SUCCESSFUL SORTIES WILL DROP BOMBS WITH A CIRCULAR NORMAL DISTRIBUTION SUCH THAT 25% OF THE BOMBS WILL STRIKE WITHIN 1000 FT. OF THE AIMING POINT? IF NOT, WHAT % IS MORE PRACTICAL FOR BETTER PLANNING?

(A) 25% within 1000' of assigned A.P. is a conservative figure for planning on visual bombing missions. It is grossly too high for blind or night bombing under present circumstances.

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22. (Q) IN BOMBING URBAN AREAS, WHAT % OF THE BOMBS DROPPED WILL FALL WITHIN THE TARGET AREA? SHOULD 100% BE REALIZED?

(A) Answer depends on size of target area, and for effectiveness, on type of bombs. 100% will fall within target only if attempt is made to concentrate on center part of target, otherwise normal dispersion of bombs will cause substantial spill-over outside target area. It should be noted also that, if IB is used, it may be ineffective in areas where density of bomb-fall is sparce.

RICHARD G. GETTELL, Deputy
Operations Analysis Division
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

16 September 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Summary of Eighth Air Force Experience with Salvo Release Extracted from ORS 'Memorandum on Salvo and Intervalometer Releases'

1. About December, 1943, during some discussions with Eighth Air Force Groups concerning possible further reductions in the dimensions of the bomb pattern, the use of salvo releases was considered. All the evidence accumulated up to that time indicated that small patterns had a smaller average aiming error than large patterns, and that the combined effect of the smaller pattern and aiming error increased the percentage of the bombs falling within 500 feet of the assigned MPI. Other considerations enter into the question as, for example, will a salvo release bring the impacts so close together as to reduce the efficiency of the destructive capacity of the bomb? On the other hand, a salvo release diminishes the number of hung up bombs.

2. Beginning with a few Groups, the salvo release was given a thorough trial and the Operational Research Section of the Eighth Air Force has collected the evidence so that certain rules can be stated to govern the use of salvo releases. The reduction in pattern dimensions and aiming error for salvo releases over maximum intervalometer was clearly demonstrated. Below 15,000 altitude intercratering of the bombs in salvo releases diminishes the destructive efficiency so that the advantage of the larger number of bombs within 500 feet of the assigned MPI is outweighed.

3. Targets were classified in four classes

a. Targets not over 3 or 4 acres in area entirely enclosed by 500 foot circle.

b. Targets approximating a 500 foot radius circle.

c. Targets not enclosed by 500 foot circle but enclosed by 2000 foot circle.

d. Very large targets - e.g. air fields.

4. Salvo release is recommended for Class a targets regardless of altitude because an increase in the proportion of direct hits results

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without increasing the chance of missing the target altogether. Targets in Classes b and c use 50 foot spacing at 15,000 foot altitudes and less, use salvo at 18,000 foot altitude and above. Between 15,000 and 18,000 choice depends on target area - salvo for small area targets - 50 foot intervalometer for large ones. Class d at least 50 foot intervalometer at all altitudes.

W. J. YOUDEN
Operations Analyst

Additional Notes on Eighth Air Force Report
on Salvo VS Intervalometer.

1. Although this is a careful study which shows, for operations from the U.K. the circumstances under which maximum damage may be expected on the ground from salvoing instead of using minimum, or 50-foot intervalometer settings, a word of caution is needed if these conclusions are to be applied to B-29 operations.

2. The composition and density of patterns studied in this report was determined, among other things, by the facts that 12-18 B-17s, carrying bomb loads of 10-12 500 lb HE bombs each, dropped on the leader.

3. It can be expected that B-29 patterns may vary when:

a. The bomb load per aircraft is substantially different from 10-12 500# HE. Variations in the number of bombs, weight per bomb, and ballistic characteristics of the bomb may lead to a significant difference in the internal composition of the bomb pattern on the ground.

b. The formation flown is different from that flown by B-17s. Variations in the number of aircraft flying together as a bombing unit, and in the spacing among them may also change the pattern of their bombfall.

4. Accordingly, it is suggested that ultimate decisions as to the appropriateness of different intervalometer settings, or salvoing, from different altitudes, or against different types of targets, be reserved until field study can be made of the composition of B-29 bomb patterns.

R. G. GETTELL
Operations Analyst

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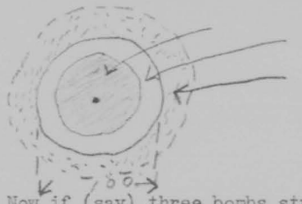
1. Very interesting report. Would personally like to have seen included some additional discussion of the following matters:

a. "Overcratering" - Efficiency loss, etc.

(1) The "damage" area for the 500 lb bomb is taken as a circle of radius 50 feet. This is okay for simple estimations, but the actual damage area may perhaps resemble somewhat the diagram below:




Now if (say) three bombs strike at about 20' distance from each other, we get an overlap of damage zones somewhat as below:

Segments "A" here receive two applications of "severe damage" instead of one. Query: Will this amount to "complete destruction" in these segments, as a result of cumulative damage?

Similarly, Segments "B" receive two applications of "Moderate to minor damage" which may total up to "severe damage".

There is further the possibility that two or three nearly simultaneous explosions may produce a blast wave more destructive than separate blast waves of individual bombs.

In sum: Are there additive factors of damage by closely spaced bombs, which somewhat reduce the inefficiency from "overcratering" as allowed for in subject report?



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b. In possible salvo bombing by B-29 formations, the shape and spacing of the formation, and the degree to which simultaneous (or other definitely planned) release by all the aircraft can be effected, would appear important. Electronic release under control of lead ship may be very advantageous, The much greater aiming errors by Eighth Air Force for minimum intervalometer release, as compared to salvo release, seem rather astounding.

W. G. de STEIGUER
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By [illegible]
The Commanding General
Army Air Forces

25 NOV 44 R.E.S.
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

25 November 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Comments on Report No. 1, XXI Bomber Command "Expected Bomb Densities Resulting from the Overlapping of Independently Aimed Bomb Patterns"

1. Formation bombing as against individual aircraft attacks has been entensively employed in this war because it has certain operational advantages under combat conditions. Even under circumstances of negligible enemy opposition it is possibly true that with the very large air forces rapidly assembled and trained under conditions of national emergency, better bombing can be done from formations led by skilled lead crews than from individual attacks. Considering how little was known at the start of the war about the problems of formation bombing, an impressive level of performance has been reached in the making and aiming of bomb patterns.

2. The first consideration has been to get as many bombs as possible on the enemy targets without too much regard for the resulting distribution of the composite bomb fall. In the case of individual attacks, theory and practice agree that if many independent aimings are made at a common aiming point, the lightest bomb density will be in the immediate neighborhood of the common aiming point with a gradual falling off in density at greater and greater distances from the aiming point. It is not so clear what the result will be if the large number of aimings are replaced by a very small number of aimed bomb patterns. It is certain that the patterns will not be exactly super-imposed and centered on the aiming point but will overlap in varying degree so that the area around the aiming point will be divided into portions covered by various multiples of the bomb density given by a single pattern. Some portions of the area may therefore be 'overbombed' and some neglected. This distribution is consequently of interest to those studying targets with a view to estimating bomb requirements. It would be one factor in choosing formation size - as, for example, whether fifty some aircraft should be dispatched as 5 formations of 11 A/C each or 8 formations of 7 A/C each.

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3. The following report gives some examples of the mathematical expectation of the portions of a 2000 x 2000 target which will be covered by one, two or more patterns and has value to operating personnel as giving a "picture" of the result of formation attacks, It is the counterpart for formation bombing of the familiar mound of bombs resulting from individual attacks.

W. J. YOUDEN,
Operations Analyst.

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
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Operations Analysis Section
XXI Bomber Command
Peterson Field

Colorado Springs, Colo.
16 November 1944.

REPORT NO. 1.

TO : Chief of Staff, XXI Bomber Command.

EXPECTED BOMB DENSITIES RESULTING FROM THE OVERLAPPING OF INDEPENDENTLY AIMED BOMB PATTERNS

If several formations attack an area target, the bombs of each forming a "bomb pattern" on the ground, the total bomb fall over the target will be uneven, a high concentration resulting where bomb patterns from several different formations overlap, while other parts will be covered by only one pattern, or will be missed completely. Thus if the attacking force consists of four (4) formations, a certain part of the target may receive as much as four (4) times the bomb density of a single bomb pattern if namely the patterns of all four (4) formations should cover this part of the target.

If a certain minimum density is required over all parts of the target, no direct use can be made of this uneven concentration of the bombs. On the other hand there are area targets for which it is unimportant that the whole target, or even which particular part of the target, is destroyed. As long as a sufficiently large portion, say a third, regardless of position within the target area, is covered by a prescribed high bomb density, the whole target will be neutralized.

In planning attacks against such targets it is possible to utilize the uneven distribution of the bombs to reduce the number of ships considered necessary to put the target out of commission. If for instance it were sufficient to cover any thirty percent (30%) of the target area with a certain bomb density and if the pattern of any one formation had one-fourth (1/4) that density, it would be necessary to send only that number of formations for which thirty percent (30%) of the target could be expected to be covered by four (4) or more bomb patterns simultaneously.

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Thus the following problem has to be solved: Given the number of formations attacking and the bomb patterns which can be expected from them, to determine how large a part of the target will on the average be covered by 1, 2, 3...of these patterns, and therefore on how large a part of the target we can expect 2, 3... times the bomb density of a single bomb pattern.

A formula giving, for any number of formations attacking, the portions of the target on which these various densities can be expected, will be derived in the appendix. From this formula the following has been computed as a typical example:

A target 2000' x 2000' is attacked by 2, 3 or 4 formations, each of which aims a pattern 3000' x 3000' with a range and deflection aiming error $\sigma$ = 1000'. The tables below give the percentages of the target which can be expected to be covered by exactly 0, 1, 2, 3 and 4 of the bomb patterns.

| 2 Formations attacking | | 3 Formations attacking | | 4 Formations attacking | |
|---|---|---|---|---|---|
| 0 | 12% | 0 | 4% | 0 | 2% |
| 1 | 45% | 1 | 24% | 1 | 11% |
| 2 | 43% | 2 | 44% | 2 | 31% |
| | 100% | 3 | 28% | 3 | 38% |
| | | | 100% | 4 | 18% |
| | | | | | 100% |

Thus if four (4) formations are attacking, it is seen that 56% of the target will on the average be covered by at least three (3) times the density of a single bomb pattern.

ERICH LEHMANN
Operations Analyst

Approved for release by:

Donald H. Loughridge,
Chief Analyst

1 Incl
Incl 1 - Appendix



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By Authority of
The Commanding General
Army Air Forces
18 Nov 44 RLS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

18 November 1944

MEMORANDUM FOR THE CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Formation Flown in Combat By XX B. C.

1. Experience shows that a group must put in a considerable amount of practice flying a given formation and aiming the resulting bomb pattern before it can do good bombing. In the ETO when the 18 to 21 A/C combat box was replaced by a formation of 12 to 14 A/C, the bombing effectiveness of the same groups decreased for a period in spite of the inherent advantages of the smaller bomb pattern. It was necessary for the lead crews to learn to aim this pattern.

2. Examination of the 41 formations bombing the last six targets assigned to XX Bomber Command shows that only 1 out of 4 formations has as many as 10 A/C altho the prescribed formation is one of 12 A/C. The detailed table shows that 15 formations were composed of 6,7,or 8 A/C, in spite of the attempt to assemble a 12 A/C formation. This suggests that a formation of approximately 7 A/C, if specified, would be attained in most instances. There are patent advantages that accrue from flying a standardized formation:

(1) A pattern of known dimensions can be more successfully aimed.

(2) It determines the bomb density on the target.

(3) It simplifies problems of defense and the avoidance of self-inflicted damage.

| No. of A/C In Formation: | Frequency of Occurrence: |
|---|---|
| 1 | 2 |
| 2 | 0 |
| 3 | 5 |
| 4 | 5 |
| 5 | 2 |
| 6 | 4 |
| 7 | 5 |
| 8 | 6 |
| 9 | 2 |
| 10 | 1 |
| 11 | 0 |
| 12 | 2 |
| 13 | 1 |
| 14 | 2 |
| 15 | 1 |
| 16 | 0 |
| 17 | 1 |
| 18 | 0 |
| 19 | 1 |
| 20 | 00 |
| 21 | 1 |
| Total No. Formations | 41 |

3. A somewhat second best formation which can be assembled seems

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preferable to a more ideal formation which is seldom attained. The assurance which comes from familiarity with the advantages and limitations of a given formation it in itself a desirable end.

W. J. YOUDEN
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

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OFFICE OF THE COMMANDING GENERAL
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The Commanding General
Army Air Forces
18 Nov 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

18 November 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Use of B-17 Wing and Group Personnel for B-29 Wing

1. For several months the VIII Bomber Command consisted of the 91,303,305 and 306th Groups. During this period the fundamental problems of large scale bombing attacks on industrial targets were revealed and good progress made in solving these problems.

2. The large formation; conceived primarily as a means of defense, was developed in detail including the problems of assembly and maintaining formation, particularly after the turn at the IP and on the bomb run. Bombing by formations not only shortens the overall time of the attack (particularly important for incendiary weapons) makes it easier for escort to provide protection, but makes it easier for escort to provide protection, but makes for better bombing. Theoretically individual aircraft attacks are most efficient. In the course of the rapid and tremendous expansion of the Air Force it was not possible to maintain the high and uniform standards characteristic of the pre-war units. The selection and additional training which can be given to lead crews can, thru the medium of the formation, be capitalized upon and the level of performance materially raised above that of the average.

3. The essence of the argument of this memorandum is that the existence of this nucleus of four groups already in working possession of the bombing techniques made possible the rapid assimilation of the new groups as they arrived in the theater. There was no kick back for the training air forces because the new groups were taught by groups which could demonstrate that the methods in use produced good bombing under combat conditions.

4. The training program of the current B-29 groups does not include any effective content of the bombing lessons developed in the European Theater. The concept of the bomb patterns, methods for making it compact, techniques of aiming the pattern are not touched upon in the training. Leader personnel in the XX Bomber Command was largely from the Pacific Area, and in the XXI Bomber Command is largely new personnel. It is certain that many of these groups will repeat the whole long process of learning on their own to bomb from formation. The XX Bomber Command is now in process of assimulating from its Commanding General the lessons of the European Theater but the supporting personnel are not well versed in the lessons.

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5. If it were possible to lift bodily from the UK an operating wing --Wing C.O. and staff, Group C.O's and staff, and a considerable proportion of the crews, and make them into a Wing in the XXI and XXII Bomber Commands a nucleus would exist which would leaven the whole Air Force. These groups would not fumble--all personnel would know their tasks. Probably two months training on B-29 aircraft would suffice before sending to the theater. These groups have flown combat boxes of 18-21 A/C - Section of 12 A/C - squadrons of 6-7 A/C and know the problems of assembly not only into formations but into task forces. They know what kind of bombing can be accomplished and would endeavor to equal or better their previous performance.

6. Aside from the direct effect discusses above the proposed may merit consideration because:

a. It would relieve the present pressure in the B-29 training program and thereby insure better trained groups.

b. It would give some valuable information to OC&R and plans on redeployment.

W. J. YOUDEN
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By authority of The Commanding General Army Air Forces
4 Nov. 44 JRLS
Date Initials

4 November 1944

NOTE FOR INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS SECTION, SECOND AIR FORCE

Subject: Observations by W. J. Youden at 504th, 505th and 6th Groups.

1. The training program is closely followed and should satisfactorily achieve the derived familiarity of crews with their equipment. A good deal more could be done in the direction of applying these acquired techniques in situations more closely resembling combat operations.

a. Bombardiers when assigned to groups know how to operate the bombsight. Some of the repeated runs over the same target circle could well be replaced with targets which would have to be found and identified.

b. Present radar targets do allow crews to acquire skill in operating the equipment but do not present problems of identification. Where runs have been made on cities, they are usually made at night, and no strike photos taken to assess the accuracy.

c. There are two broad types of problems arising in formation bombing not covered in present training program.

(1) The group must learn to put up a formation which is capable of making a good bomb pattern and accurately aiming the pattern.

(2) Command must plan the attack (e.g. specify spacing between formations) so that each formation has the best possible chance to do the bombing it is capable of doing.

2. In formation bombing whether the wing ships drop on the lead ship or sight individually for range, the resulting bomb fall is termed a bomb pattern. A group should practice formation flying and take strike photos of the bomb patterns. A photo plane flying above should photograph the formation about the time of bomb releases. By studying both the pictures of the formation and the bomb pattern, it can be determined whether a poor pattern arises from poor formation flying or lack of a common bomb release line or both. Improvement can only be expeditely attained if it is known where the improvement must be made.

3. In aiming a pattern it is not where the lead bombs go that is important, but where the center of the pattern goes. To aim the pattern the

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lead bombardier (where all drop on the leader*) must know where his bombs are in the pattern. In every theater the uncertainty on this score has far exceeded the aiming error of the lead bomb. No training is given in this vital step of the bombing procedure. Nor any instruction on how to determine the magnitude of the offset required in order to center the pattern.

4. In early procedure, which may also be employed on missions against enemy targets, where bombs not exceeding 500 pounds are carried by the formation is to put 2000 pound bombs in the lead ship. On the strike photos the large bursts are located. They are moved back on the print for the difference in range for the 2000 pound over the small bomb. This determines the point where the lead bombs would have gone if they had been the same bombs as the formation carried. It goes without saying that the lead bombardier uses the data for the small bombs in making his sighting, since his bombs serve as a signal for the others and must go away at the instant they would have gone if they were small bombs.

5. Instruction should be given on the importance of making the bomb patterns small in dimension since the effectiveness of pattern bombing is very much influenced by pattern size.

6. Command should be familiar with the principles of pattern bombing and have in it someone able to estimate expected bomb densities on target, or in other words, estimate force requirements for specific targets.

W. J. YOUDEN
Operations Analyst
Twentieth Air Force

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*There exists ample combat evidence in support of this technique.



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

13 December 1944

NOTE TO CHIEF OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Bomb Bay Turbulence - Tests with 100 and 500 lb Bombs

1. Tests show that bombs from rear stations of both bomb bays come out nose down - get further whipped down when nose enters air stream and violently whipped back as tail emerges. Bombs oscillate wildly, immediately take on pronounced, exaggerated trail, bombs from rear of front bomb bay threading through bombs from rear bomb bay. If front bomb bay doors closed the situation in rear bomb bay is aggravated. Fuel tanks in front bomb bay produce similar aggravation even if front bomb bay doors are opened.

2. Evidence consists of:

a. A large number of still pictures taken from photo ship flying along side.

b. Movies of releases taken from both photo ship and from B-29.

c. Photos taken inside B-29 bomb bay of bombs with pieces of yarn attached clearly show course of wind stream.

d. Train releases of numbered bombs which when dug up clearly showed bombs from rear stations of both bomb bays far back in the train and in chaotic order.

3. This evidence has been examined in great detail by Mr. Williams, Boeing Company representative, who finds it absolutely conclusive. He is enroute to Washington with photos, sketches, and notes which he will present Saturday, 16 December to the Chief aerodynamaist of the company at present in Washington. Mr. Williams is certain that a complete case has been made for the existence of this difficulty and is of the opinion that it will not be difficult to remedy. It is his intention to seek immediately Air Force authorization to initiate remedial measures which will eliminate:

a. The occurrence of chance impact of bombs

b. The greatly distorted trail, in instances well over 1000 feet too large.

W. J. YOUDEN
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

22 December 1944

NOTE FOR THE INFORMATION OF:
CHIEF OF STAFF, TWENTIETH, AF.

Subject: Progress of Bombing Turbulence Tests

1. The following telephone message was received this morning from Mr. Eugene Williams of the Boeing Company:

"One flight test, on which forty practice bombs weighing 100 lbs. were dropped, has been completed and indications are that the condition has been vastly improved--if not made completely satisfactory. I am forwarding this information to you in an unofficial manner because we wish to run two more tests before we feel we are in a position to make an official report. You can give this information to whom ever you deem should have it. I personally am enthusiastic and looking forward to having films and movies, which were taken of the tests, with me when I return to Washington, Saturday morning."

ROBERT L. STEARNS, Chief
Operations Analysis Division

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WNT/elw
19 January 1945

MEMORANDUM TO DEPUTY CHIEF OF STAFF, COMBAT OPERATIONS, TWENTIETH AIR FORCE.

Subject: Comments On Naval Air Station Report, " Development Of New Minelaying Techniques." (Project TED No. PTR - 31A47 Report dated 30 December 1944).

1. The report describes the adaptation of various standard navigational procedures, using radar landmarks, to the problem of minelaying. None of the procedrues is particularly novel from the standpoint of navigational technique, but the report is important in that it shows that methods of this kind can yield accuracies approaching the maximum of which the radar equipment is capable in the direct bombing of point targets.

2. This confirms the claims which have been made in a recent Operations Analysis Division memorandum (dated 18 November 1944) that such accuracies can be obtained with any one of several offset methods, and that the choice between methods, in consequence, should be governed primarily by such factors as the simplicity of the operations which are required, the ease of Instructing inskilled operators in the method, and the extent of the pre-mission preparation on which is required.

3. It is believed that the methods of the report require a fairly high degree of navigational skill and versatility on the part of the radar operator. More variety of techniques may be required in minelaying however, than in strategic bombing because it is frequently desired to lay mines in train along a channel.

4. It is believed that a simplified procedure requiring only a single reference point, such as described in the earlier memorandum referred to above, will probably prove as accurate as the minelaying procedures described and preferable for our operations from the training and briefing standpoints.

W. N. HUTTLE,
Operations Analyst

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LAB/rab
Ext. 4819

14 February 1945

Major General Curtis E. LeMay
Commanding General,
XXI Bomber Command,
APO No. 234, c/o Postmaster,
San Francisco, California.

Dear Curt:

I am detailing Major Robert S. Bennett to your Command on a special assignment that appears to have very great potentialities. He has presented a proposed method of analysis of visual bombing operations by photographic means that has so impressed some of us that I think it should be given a full-dress trial. The attached memoranda describe what the method proposes to accomplish, and Major Bennett is bringing with him a full exposition of the method.

I feel free to ask you to give him every opportunity to develop his method under combat conditions, which he frankly admits may require several missions in order to iron out the rough spots, because the potential gain is large and also because it appears to fit smoothly into your present plan of operation without additional equipment or personnel. He was at the Second Air Force when the XXI Bomber Command was in training and worked with your Photo and P.I. people there. Being on friendly terms with these people is a good thing because their cooperation will be essential; he must be able to place cameras where he needs them, have them activated automatically with the bomb-release switch, etc. He will use slightly modified methods of plotting; he will need photogrammetric plots of the target areas, etc.

Though I don't anticipate such, if Bennett should run into a snag anywhere, I'd appreciate it if you'd smooth it out. I feel very strongly that his proposal merits a fair trial.

Cordially,

LAURIS NORSTAD
Brigadier General, U.S. Army,
Chief of Staff.

2 Incls:
1. Memo for C/S Twentieth AF from Major Bennett
2. Memo for C/S Twentieth AF from OAD, Twentieth AF

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14 February 1945

MEMORANDUM FOR THE CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: A Method for Determining Bombing Patterns by Photographic Means.

1. Present methods for preparing bomb plots are not entirely satisfactory as they depend primarily upon securing strike photographs which often are not operationally feasible.

2. The proposed method of analyzing bombing operations by photographic means has been explained in detail to the Operations Analysis Division, Twentieth Air Force. It is based on photogrammetric and bombing principals which have been in use but have not been combined in a manner to permit full utilization of available photography. The proposed combination of those principles was tested by the undersigned in the Second Air Force in connection with the preparation of Second Air Force Regulation 50-70 (Camera Bombing) and in preparing a report, subject, "Analyzing Bombing Results by Photographing the Descending Bombs." Similar tests were also recently conducted by Mr. Dale Corson, of the Air Communications Office.

3. The method is largely independent of actual bomb strike photos. It depends instead upon a photo taken at instant of bomb release and one or more additional photos on pre-set time intervals, plus full utilization of pre-raid reconnaissance, maps and, previous strike photography.

4. The method requires no additional equipment or personnel, above that at present assigned and more importantly, it does not impose any operational restrictions or difficulties, but has been designed to fit present bombing procedures of the XX and XXI Bomber Commands.

5. The salient advantage of the method is that inaccuracies and difficulties introduced by tilt of the camera are eliminated. This enables a more accurate determination of the position of the aircraft in space at instant of taking each photograph. A reliable basis is thereby established for computing the trajectory of the bombs; and consequently a more reliable bomb plot of the probable strikes can be made, even in absence of actual strike photos.

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6. The proposed method when bombing is visual will give the following information:

a. Relative position of each A/C in the formation at time of bomb release.

b. Position in space of each A/C at time of bomb release (or at any time of taking of a photograph).

c. The location of bothH E and IB patterns from all formations without the actual impact photographs. This is important as present bomb plots usually do not furnish sufficient information for proper weapon analysis. It is believed that this method will enable a much larger percentage of bombs to be plotted on the bomb plots, with the result that weapon analysis - particularly of I.B. - will be materially improved.

d. Additional information incidental to the above which can be secured by more detailed study and analysis includes the following:

(1) Effectiveness of different formations.

(2) Magnitude and effect of sighting errors.

(3) Effect of faulty release.

(4) Aiming point identification

(5) Effect of differantial ballistic winds.

ROBERT S. BENNETT
Major, A.C.

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WGdeS/elw
14 February 1945

MEMORANDUM FOR CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: Assignment of Major Robert S. Bennett to Temporary Duty With XXI Bomber Command.

1. It is recommended that arrangement be made for assignment of Major Robert S. Bennett to temporary duty with XXI Bomber Command, with authority to give his photographic methods for analysis of bombing operations a thorough trial under combat conditions.

2. Such trial is considered advisable for the following reasons:

a. The procedures he proposes have been successfully used in camera bombing, etc., at Second Air Force.

b. His past experience, both civilian and military, appears to qualify him excellently for this duty. (See attached record).

c. He has personal acquaintance with, and has in the past worked with, the Photo and P.I. personnel of XXI Bomber Command. This factor should facilitate all necessary cooperation between him and the people in the theater.

d. It is believed that Major Bennett's method will fit easily into present bombing procedures of the XX and XXI Bomber Commands, without requiring additional equipment or personnel.

e. The method appears to have good possibility of furnishing promptly (made in the theater) bomb plots which will be highly useful for weapon analysis purposes. This should eliminate the delay and the duplication of effort involved in making such plots here in AAF Headquarters. It is further anticipated that the methods will in many cases provide usable bomb plots which could otherwise not be made at all.

f. The method appears to have good possibility of furnishing much needed information as to actual formations flown at instant of bomb release. This should open new fields of study and provide data of great value for operational planning and procedures.

g. The method appears to have good possibility of providing data on such matters as aiming point identification, effects of differential ballistic wind, divergence in course flown by elements of the

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bombing formation, and other factors affecting bombing accuracy and bomb patterns.

APPROVED:

ROBERT L. STEARNS, Chief
Operations Analysis Division CST

LeROY A. BROTHERS

WALTER G. de STEIGUER
Lt. Col., Air Corps

Operations Analysts

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EXPERIENCE RECORD - MAJOR ROBERT S. BENNETT, O-917886
Primary M.O.S. 8503, Additional M.O.S. 9301
Date of Birth: 8 October 1907

A. Civilian experience:

1. Forest Service, U.S. Dept. Agr. 1929-1935. Civil and Mapping Engineer. Performed all types of survey and mapping work including hydrographic, topographic, and construction lay-out surveys. Began using aerial surveys at this time. During this period, supervision was exercised over from 10 to 50 surveyors, engineers, draftsmen, computors, and photogrammetrists engaged in the above work. Acted as technical liaison man between Legal, Purchase, and Engineering Departments.

2. U. S. Army, Corps of Engineers. 1935 to 1942. Chief Surveys and Mapping Section, Huntington, W. Va. District. Exercised supervision over from 50 to 175 surveyors, engineers, computors, draftsmen and photogrammetrists engaged in varied engineering and surveying, and mapping work. Included, were hydrographic, topographic, land and construction lay-out surveys, and maps for dams, bridges, floodwalls, and various structures. Developed a surveying system utilizing aerial photography, and conventional methods which greatly facilitated this work and is S.O.P. in the Huntington District. During this period, studied in detail the subject of photogrammetry and the interpretation and use of aerial photographs. 50% of the work during this period was executive and administrative as well as technical. Position occupied necessitated preparation of operational plans and estimates for the Section, and required close coordination and liaison with other departments of the District as well as with other government and civilian agencies and firms.

B. Military experience:

(1). C.M.T.C. 1924

(2). Two enlistments National Guard. 1924 and 1927

(3). Commissioned as 1st Lt. A.U.S. 1 October 1942

a. OTS Miami Beach, Fla. October 1942

b. Air Intelligence School, Harrisburg, Pa. (Photo Intelligence) November 1942.

c. Dec. 1942 to March 1944 assigned as Executive Officer and later as Commanding Officer, 6th AAF Photo Intelligence Detachment, Hq. Second Air Force. Performed photo interpretation work and planned and assisted in work necessary in training a Photo Intelligence Detachment for combat duty.

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The detachment also assisted the Second Air Force training program by publishing photo intrepretation material and conducting training schools for officers and enlisted personnel in the Air Force.

d. March 1944 to June 1944. Photo Intelligence officer on staff of Director of Intelligence Training, Second Air Force.

e. June 1944 to Sept. 1944. Photo Intelligence officer on staff of Photographic Officer and AC of S, A-2, XXI Bomb. Command

f. Sept. 1944. Transferred to Hq. AAF for duty in Analysis Division, Office of the AC of AS, Intelligence. (Joint Target Group)

C. Miscellaneous:

1. While in Second Air Force, and at the request of Col. William M. Garland, made a detailed study of bombing problems and accuracy and as a result of this study, developed a new system for conducting and accurately scoring camera bombing. This system was adopted and put in use as Second Air Force Regulation 50-70. This system, which is based on the ability to score a tilted photograph, by a simple graphical procedure, is also used by Radar Training Units, and is published for information in the September 30, 1944 issue of Radar Magazine. During the study and testing of the above system, flew approximately 70 hours in B-17 and B-24 aircraft as an observer and aerial photographer.

2. Have approximately 75 hours solo civilian flying in light aircraft (50 to 250 H.P.)

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HEADQUARTERS, TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

WASHINGTON, D. C.

25 April 1945

# THE PROPORTION OF BOMBS EXPECTED TO FALL IN A TARGET AREA

Report Prepared By:

Hugh J. Miser

HUGH J. MISER
Operations Analyst

APPROVED FOR RELEASE:

ROBERT L. STEARNS, Chief,
Operations Analysis Division, CST

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## SUMMARY

This report gives a simple, quick method of computing the average per cent of bombs dropped that will fall in a given target area.

This method can be used in planning future operations, and in evaluating current operations. The computation depends upon the dimensions of the target area and the average past performance of the air force as regards pattern size and aiming error of pattern centers.

A single page in the Appendix, convenient for field use, explains the method and supplies the necessary table. An alternate graphical method is given in the Appendix, also complete on a single page.

The report also discusses the validity of theory on which the method is based.

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## I. DISCUSSION OF THE USE OF THE TABLES.

1. In the theory from which the tables are computed it is assumed that the pattern and the target area are both rectangles. In most analyses of bombing accuracy, patterns are considered as rectangles. For target areas that are not rectangles, a rectangle of equivalent area which encloses the vital installations will give a satisfactory result.

2. In the theory from which the tables are computed it is assumed that "widths" are dimensions across the track, and that "lengths" are dimensions along the track. However, in almost all cases the effect of ignoring this assumption is negligible. Therefore, the example accompanying the table uses the terms length and width in the ordinary sense. This matter is discussed further in Section II.

3. The Cep used is the Cep of pattern centers, i.e., if a number of bomb plots are superimposed so as to have a common aiming point, the Cep is the radius of the circle with center at the aiming point which contains one-half of the pattern centers. Or, if the radial aiming error is defined as the distance between the aiming point and pattern center, then

$$\text{Cep} = 0.939 \times \text{average radial aiming error.}$$



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4. Thus, the Cep of pattern centers and the average pattern dimensions represent the average past performance of the air force. If these figures are kept up-to-date by using averages over recent, representative raids, good estimates of average raid effectiveness can be obtained for specific targets.

## II. THE VALIDITY OF THE RESULTS.

1. Since the method given in this report is based upon a mathematical theory, rather than upon a collection of observational data, it is important to see how computed results compare with actual data. Table I shows such a comparison for a comprehensive selection of Eighth Air Force data. The table gives the per cent of bombs within 500', 1,000', and 2,000' of the aiming point; in the computed results the target was chosen as a square with area equal to that of the given circle.

2. For the 500 ft. circle about the A.P. the computed estimates are smaller than the recorded averages by an average of 4%. This discrepancy, since it is fairly uniform, can probably be accounted for as follows: In the theory the bombs are assumed to be evenly distributed over the pattern, whereas in actual patterns they have a slight tendency to pile up in the middle of the pattern and thin out at the edges. For the 1,000 ft. circle the average of the computed estimates is about equal to the average of the recorded estimates, although in the last period the computed estimates are too small. For the 2,000 ft. circle, the computed estimates are much too large in the earlier period, and approximately correct in the later period. Since the data of the later period are probably more representative and reliable than those of the earlier period, we are led to the following tentative conclusions:

a. The assumptions upon which the theory is based are ~~not~~ must fairly well in practice.

b. For target areas up to 3½ million square feet, estimates computed on the basis of this theory will be too small by about 5%. For larger targets the estimates will be approximately correct. Further experience should throw more light on these matters.

3. Table 2 shows for a few examples a comparison between the expectation obtained when it is assumed that the axis of attack is along the length of the target area and the expectation obtained when it is assumed that the axis of attack is along the width of the target area.

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TABLE I

| Period | No. of Aimings | Type of Formation | Av. Pattern Dimensions | Recorded MPE | Computed Cep | Average per cent of Bombs Within 500' of A.P. Recorded | 500' of A.P. Computed | 1000' of A.P. Recorded | 1000' of A.P. Computed | 2000' of A.P. Recorded | 2000' of A.P. Computed |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Jan.-Oct. 1943 | 64 | | 2050 x 2500 | 1100 | 1030 | | | 35 | 33 | | |
| | 62 | | 2350 x 3550 | 1270 | 1190 | | | 24 | 23 | | |
| | 57 | | 3200 x 4800 | 1250 | 1175 | | | 20 | 17 | | |
| 2. Oct. 1943 to Mar. 1944 | 36 | 6-7 | 900 x 1400 | 1150 | 1080 | 16 | 12 | 38 | 40 | 61 | 86 |
| | 19 | 9 | 1600 x 1900 | 1200 | 1130 | 12 | 10 | 27 | 34 | 46 | 81 |
| | 115 | 12-14 | 2000 x 2400 | 1040 | 980 | 9 | 10 | 25 | 35 | 54 | 83 |
| | 170 | 18-21 | 2000 x 2250 | 930 | 875 | 14 | 12 | 37 | 40 | 66 | 88 |
| 3. Apr.-July 1944 | 34 | 12-14 | 1950 x 2100 | 850 | 800 | 18 | 14 | | | | |
| | 92 | 12-14 | 1750 x 1800 | 710 | 667 | 25 | 19 | | | | |
| | 132 | 12-14 | 1950 x 2150 | 890 | 836 | 19 | 13 | | | | |
| | 34 | 18-21 | 2100 x 2400 | 1020 | 960 | 14 | 10 | | | | |
| | 90 | 18-21 | 1900 x 1900 | 690 | 645 | 23 | 17 | | | | |
| 4. Sept-Oct. 1944 | 34 | 9-10 | 1500 x 1750 | 1120 | 1050 | 19 | 12 | 50 | 38 | 82 | 85 |
| | 153 | 12-14 | 1650 x 1800 | 1020 | 960 | 20 | 15 | 48 | 41 | 83 | 87 |

The data above is taken from Eighth Air Force Operations Analysis Reports, as follows:

1. Report dated 31 October 1943, Analysis of VIII Bomber Command operations from the point of view of bombing accuracy.
2. Report dated 12 April 1944, Report on Bombing Accuracy 10 October 1943 - 1 March 1944.
3. Report dated 16 September 1944, Memorandum on salvo and intervalometer releases.
4. Report dated 6 November 1944, Report on bombing accuracy for the months of September and October.



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TABLE 2

| Cep | Pattern Dimensions | Target Dimensions | Expected % of Bombs on Target for Axis of Attack Along Length | Along Width |
|---|---|---|---|---|
| 1000 | 1500 x 2000 | 1000 x 1500 | 21.0 | 20.8 |
| 750 | 1250 x 1500 | 750 x 1500 | 25.7 | 25.3 |
| 1000 | 1500 x 2000 | 500 x 1500 | 10.8 | 10.7 |
| 1000 | 1500 x 2000 | 250 x 2000 | 6.9 | 6.7 |
| 1000 | 1500 x 2000 | 100 x 2000 | 2.8 | 2.7 |
| 500 | 750 x 1000 | 100 x 2000 | 7.9 | 7.3 |

This table shows clearly that it is completely satisfactory to ignore the axis of attack in making computations. The error caused by this procedure is usually less than 1%, and always less than the expected difference between theory and experience.

## III. USES OF THE METHOD

1. Since the preceding section shows that results obtained by the methods of this report are realistic, two operational uses are suggested:

a. Planning future raids on area targets. Knowing the proportion of bombs that can be expected to hit a given target area, one can plan to use a force large enough that this proportion times the number of bombs carried will equal the number of bombs that the command desires to place within the target area. For a single raid, of course, this theory does not assure the command that precisely the computed number of bombs will fall in the target area; more bombs, or fewer, may hit the target area, or the attacking force may miss it completely. This theory tells the command how many bombs can be expected to fall in a given rectangular target area on a given raid if the raid is an average raid, i.e., if average pattern size and aiming error on the raid are equal to the average pattern size and aiming error of the air force on past raids. Thus more than the computed number of bombs should fall in the target area about half of the time, and less than the computed number of bombs should fall in the target area about half of the time.



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b. Measuring the performance of current operations from the point of view of bombing accuracy. The expectation computed by the method of this report depends upon the average past performance of the air force. Thus it is easy to see whether or not a current raid is better than the past average would lead one to expect. For example, if a computation shows that 20% of the bombs dropped could be expected to hit the target area on a raid, and 30% actually hit the target area, then the attacking force has exceeded what its past average performance would lead one to expect; if only 10% hit the target, the force has fallen below its past average performance. In this way the command can use results obtained by the method of this report in setting up standards of performance that it can reasonably expect its force to attain. These standards can be used as a partial basis for commendation or criticism.

## IV. THE THEORY OF THE METHOD

1. The tables given in this report are based on a theory derived by L. B. C. Cunningham in A.W.A.S. Departmental Note No. 11, "The Mathematical Expectation of Strategic Damage to Extended Targets." The expression tabulated in the tables is

$$\left[f(0.589\,|A+B|\,) - f(0.589\,|A - B|\,)\right]/0.589A$$

where

A = Pattern dimension / Cep

B = Target dimension / Cep

$$f(x) = x\int_0^x g(t)dt + g(x)$$

$$g(t) = \left[\exp(-t^2/2)\right]/\sqrt{2\pi}$$

Thus the argument A is read across the top of the table, the argument B down the side.

2. The tables were computed by the Operations Analysis Section, FEAF, and published in a different form in an OAS report (undated), "The Number of Aircraft Formations Computer". The contribution of the present report is to reduce the bulk of the tabular data, by changing the form of the tables and the method of their use.



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## APPENDIX

1. Page A gives the necessary table and an example of its use.

2. Page B gives a table like that on page A, but for more extended values of the arguments. The table on page A will be adequate for most situations.

3. Page C gives a graph from which the expected per cent of hits on a square target area can be read off at a glance. The graph can also be used for non-square targets, and an explanation of the method is given. The method of page A will probably be preferred in this latter case, although both methods lead to the same results.

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Pattern Width/Cep (or Pattern Length/Cep)

| Target Width/Cep or Target Length/Cep | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 047 | 047 | 047 | 046 | 045 | 045 | 044 | 042 | 041 | 040 | 038 | 037 | 035 | 034 | 032 | 031 | 030 | 028 | 027 | 026 | 025 |
| 0.2 | 094 | 094 | 093 | 092 | 090 | 089 | 087 | 084 | 082 | 079 | 076 | 073 | 070 | 067 | 064 | 062 | 059 | 056 | 054 | 051 | 050 |
| 0.3 | 140 | 140 | 139 | 137 | 135 | 133 | 130 | 126 | 122 | 118 | 114 | 109 | 105 | 101 | 096 | 092 | 088 | 084 | 080 | 077 | 074 |
| 0.4 | 186 | 186 | 185 | 182 | 180 | 176 | 172 | 167 | 162 | 157 | 151 | 146 | 140 | 134 | 128 | 123 | 117 | 112 | 107 | 103 | 098 |
| 0.5 | 232 | 231 | 229 | 227 | 224 | 219 | 214 | 208 | 202 | 195 | 189 | 181 | 174 | 167 | 160 | 153 | 146 | 140 | 134 | 128 | 123 |
| 0.6 | 276 | 276 | 274 | 271 | 267 | 262 | 256 | 249 | 242 | 234 | 225 | 217 | 209 | 200 | 192 | 183 | 175 | 168 | 160 | 153 | 147 |
| 0.7 | 320 | 319 | 317 | 314 | 309 | 303 | 296 | 289 | 280 | 271 | 262 | 252 | 242 | 233 | 223 | 213 | 204 | 195 | 187 | 179 | 171 |
| 0.8 | 362 | 362 | 359 | 356 | 350 | 344 | 336 | 328 | 318 | 308 | 298 | 287 | 276 | 265 | 254 | 243 | 233 | 223 | 213 | 204 | 195 |
| 0.9 | 404 | 403 | 400 | 396 | 391 | 384 | 375 | 366 | 355 | 344 | 333 | 321 | 309 | 297 | 285 | 273 | 261 | 250 | 239 | 229 | 220 |
| 1.0 | 444 | 443 | 440 | 436 | 430 | 422 | 413 | 403 | 392 | 380 | 367 | 354 | 341 | 328 | 315 | 302 | 289 | 277 | 265 | 254 | 244 |
| 1.1 | 483 | 482 | 479 | 474 | 468 | 460 | 450 | 439 | 427 | 414 | 401 | 387 | 373 | 359 | 345 | 331 | 317 | 304 | 291 | 279 | 268 |
| 1.2 | 520 | 519 | 516 | 511 | 504 | 496 | 486 | 474 | 462 | 448 | 434 | 419 | 404 | 389 | 374 | 359 | 345 | 331 | 317 | 304 | 291 |
| 1.3 | 555 | 555 | 552 | 547 | 540 | 531 | 520 | 508 | 495 | 481 | 466 | 451 | 435 | 419 | 403 | 387 | 372 | 357 | 342 | 328 | 315 |
| 1.4 | 589 | 589 | 586 | 581 | 573 | 564 | 553 | 541 | 528 | 513 | 497 | 481 | 465 | 448 | 432 | 415 | 399 | 383 | 367 | 353 | 339 |
| 1.5 | 622 | 622 | 618 | 613 | 606 | 596 | 585 | 573 | 559 | 544 | 528 | 511 | 494 | 477 | 459 | 442 | 425 | 408 | 392 | 377 | 362 |
| 1.6 | 653 | 652 | 649 | 644 | 636 | 627 | 616 | 603 | 589 | 573 | 557 | 540 | 522 | 508 | 487 | 469 | 451 | 434 | 417 | 401 | 385 |
| 1.7 | 683 | 682 | 679 | 673 | 666 | 656 | 645 | 632 | 618 | 602 | 585 | 568 | 550 | 532 | 513 | 495 | 477 | 459 | 441 | 424 | 408 |
| 1.8 | 710 | 710 | 706 | 701 | 693 | 684 | 672 | 659 | 645 | 629 | 613 | 595 | 577 | 558 | 539 | 520 | 502 | 483 | 465 | 448 | 431 |
| 1.9 | 736 | 736 | 732 | 727 | 719 | 710 | 699 | 686 | 671 | 656 | 639 | 621 | 603 | 584 | 565 | 545 | 526 | 507 | 489 | 471 | 453 |
| 2.0 | 761 | 760 | 757 | 751 | 744 | 735 | 723 | 711 | 696 | 681 | 664 | 646 | 628 | 609 | 589 | 570 | 550 | 531 | 512 | 493 | 475 |
| 2.1 | 783 | 783 | 779 | 774 | 767 | 758 | 747 | 734 | 720 | 704 | 688 | 670 | 652 | 633 | 613 | 593 | 573 | 554 | 535 | 516 | 497 |
| 2.2 | 804 | 804 | 801 | 796 | 789 | 780 | 769 | 756 | 743 | 727 | 711 | 693 | 675 | 656 | 636 | 616 | 597 | 577 | 557 | 537 | 519 |
| 2.3 | 824 | 823 | 820 | 815 | 809 | 800 | 789 | 777 | 764 | 749 | 732 | 715 | 697 | 678 | 658 | 639 | 619 | 599 | 579 | 559 | 540 |
| 2.4 | 842 | 841 | 839 | 834 | 827 | 819 | 809 | 797 | 784 | 769 | 753 | 736 | 718 | 701 | 680 | 660 | 640 | 620 | 600 | 580 | 561 |
| 2.5 | 858 | 858 | 855 | 851 | 844 | 836 | 827 | 815 | 802 | 788 | 773 | 756 | 738 | 720 | 701 | 681 | 661 | 641 | 621 | 601 | 581 |
| 2.6 | 874 | 873 | 871 | 866 | 860 | 853 | 843 | 832 | 820 | 806 | 791 | 775 | 758 | 740 | 721 | 701 | 681 | 661 | 641 | 621 | 601 |
| 2.7 | 888 | 887 | 885 | 881 | 875 | 868 | 859 | 848 | 836 | 823 | 809 | 793 | 776 | 758 | 740 | 721 | 701 | 681 | 661 | 641 | 621 |
| 2.8 | 900 | 900 | 898 | 894 | 888 | 881 | 873 | 863 | 852 | 839 | 825 | 810 | 793 | 776 | 758 | 739 | 720 | 700 | 680 | 660 | 640 |
| 2.9 | 912 | 912 | 909 | 906 | 901 | 894 | 886 | 877 | 866 | 854 | 840 | 826 | 810 | 793 | 776 | 757 | 738 | 719 | 699 | 679 | 659 |
| 3.0 | 923 | 922 | 920 | 917 | 912 | 906 | 898 | 889 | 879 | 867 | 855 | 841 | 825 | 809 | 792 | 774 | 756 | 736 | 717 | 697 | 677 |
| 3.1 | 932 | 931 | 930 | 926 | 922 | 916 | 909 | 901 | 891 | 880 | 868 | 855 | 840 | 824 | 808 | 790 | 772 | 754 | 734 | 715 | 695 |
| 3.2 | 940 | 940 | 938 | 935 | 931 | 926 | 919 | 911 | 902 | 892 | 880 | 868 | 854 | 839 | 823 | 806 | 788 | 770 | 751 | 732 | 712 |
| 3.3 | 948 | 947 | 946 | 943 | 939 | 934 | 928 | 921 | 912 | 902 | 892 | 880 | 867 | 852 | 837 | 821 | 804 | 786 | 767 | 748 | 729 |
| 3.4 | 955 | 954 | 953 | 950 | 947 | 942 | 936 | 930 | 922 | 912 | 902 | 891 | 879 | 865 | 850 | 836 | 818 | 801 | 783 | 764 | 745 |
| 3.5 | 961 | 960 | 959 | 957 | 953 | 949 | 944 | 938 | 930 | 922 | 912 | 902 | 890 | 877 | 863 | 848 | 832 | 815 | 798 | 779 | 761 |
| 3.6 | 966 | 966 | 964 | 962 | 959 | 955 | 951 | 945 | 938 | 930 | 922 | 911 | 900 | 888 | 875 | 860 | 845 | 829 | 812 | 794 | 776 |
| 3.7 | 971 | 970 | 969 | 967 | 965 | 961 | 957 | 951 | 945 | 938 | 929 | 920 | 910 | 898 | 886 | 872 | 857 | 842 | 825 | 808 | 791 |
| 3.8 | 975 | 974 | 973 | 972 | 969 | 966 | 962 | 957 | 952 | 945 | 937 | 928 | 918 | 908 | 896 | 883 | 869 | 854 | 838 | 822 | 804 |
| 3.9 | 978 | 978 | 977 | 976 | 974 | 971 | 967 | 962 | 957 | 951 | 944 | 936 | 927 | 917 | 905 | 893 | 880 | 866 | 850 | 835 | 818 |
| 4.0 | 981 | 981 | 980 | 979 | 977 | 974 | 971 | 967 | 962 | 957 | 950 | 943 | 934 | 925 | 914 | 903 | 890 | 877 | 862 | 847 | 831 |

| | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

EXPECTED PER CENT OF BOMBS ON A RECTANGULAR TARGET

For pattern bombing from formations the table given above can be used to compute the average per cent of bombs that can be expected on a rectangular target, as the following example shows:

If the record of 12-plane formations in an air force is as follows:
Cep of pattern centers: 800 feet
Average pattern dimensions: 1000 feet by 1200 feet
what ppr cent of the bombs from these formations can be expected to hit a target whose dimensions are 1200 feet by 1600 feet?

Computations: Target width/Cep = 1200/800 = 1.50
Pattern width/Cep = 1000/800 = 1.25
With these two figures we enter the table to find the Width Factor = 0.582 .

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Target length/Cep = 1600/800 = 2.00
Pattern length/Cep = 1200/800 = 1.50
With these two figures we enter the table to find the Length Factor = 0.704 .

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Then the expected per cent of bombs that will hit the target is:

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100xWidth Factor x Length Factor = 100 x 0.582 x 0.704 = 41.1% .

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Pattern Width/Cep (or Pattern Length/Cep)

| Target Width / Cep or Target Length / P | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.25 | 117 | 115 | 111 | 104 | 095 | 085 | 077 | 069 | 062 | 055 | 050 | 046 | 042 | 039 | 036 | 034 | 031 | 030 | 028 | 027 | 025 |
| 0.50 | 232 | 228 | 219 | 205 | 188 | 171 | 153 | 137 | 122 | 110 | 100 | 091 | 083 | 077 | 071 | 067 | 062 | 059 | 056 | 053 | 050 |
| 0.75 | 341 | 337 | 324 | 304 | 280 | 254 | 228 | 204 | 183 | 165 | 149 | 136 | 125 | 115 | 107 | 100 | 094 | 088 | 083 | 079 | 075 |
| 1.00 | 444 | 438 | 422 | 397 | 367 | 334 | 302 | 271 | 243 | 219 | 199 | 181 | 166 | 154 | 143 | 133 | 125 | 118 | 111 | 105 | 100 |
| 1.25 | 538 | 531 | 513 | 485 | 450 | 412 | 373 | 336 | 303 | 274 | 248 | 227 | 208 | 192 | 178 | 167 | 156 | 147 | 139 | 132 | 125 |
| 1.50 | 622 | 616 | 596 | 565 | 527 | 485 | 442 | 400 | 362 | 327 | 297 | 272 | 250 | 231 | 214 | 200 | 187 | 176 | 167 | 158 | 150 |
| 1.75 | 697 | 690 | 670 | 639 | 599 | 554 | 507 | 462 | 419 | 380 | 346 | 317 | 291 | 269 | 250 | 233 | 219 | 206 | 194 | 184 | 175 |
| 2.00 | 761 | 754 | 734 | 703 | 663 | 618 | 569 | 521 | 475 | 433 | 395 | 361 | 332 | 307 | 286 | 267 | 250 | 235 | 222 | 210 | 200 |
| 2.25 | 815 | 808 | 789 | 760 | 722 | 676 | 627 | 577 | 529 | 484 | 442 | 406 | 374 | 346 | 321 | 300 | 281 | 265 | 250 | 237 | 225 |
| 2.50 | 858 | 853 | 836 | 809 | 772 | 729 | 681 | 631 | 581 | 533 | 489 | 450 | 415 | 384 | 357 | 333 | 312 | 294 | 278 | 263 | 250 |
| 2.75 | 895 | 889 | 874 | 850 | 817 | 776 | 730 | 680 | 630 | 581 | 535 | 493 | 455 | 422 | 392 | 366 | 344 | 323 | 306 | 289 | 275 |
| 3.00 | 923 | 918 | 905 | 884 | 854 | 817 | 774 | 726 | 677 | 627 | 580 | 536 | 495 | 460 | 428 | 400 | 375 | 353 | 333 | 316 | 300 |
| 3.25 | 944 | 940 | 930 | 912 | 886 | 853 | 813 | 768 | 720 | 671 | 623 | 577 | 535 | 497 | 463 | 433 | 406 | 382 | 361 | 342 | 325 |
| 3.50 | 961 | 957 | 949 | 934 | 912 | 883 | 847 | 806 | 761 | 713 | 665 | 618 | 574 | 534 | 498 | 466 | 437 | 412 | 389 | 368 | 350 |
| 3.75 | 973 | 970 | 963 | 951 | 933 | 908 | 877 | 840 | 797 | 751 | 704 | 657 | 613 | 571 | 533 | 499 | 468 | 441 | 417 | 395 | 375 |
| 4.00 | 981 | 980 | 974 | 965 | 950 | 929 | 902 | 869 | 830 | 787 | 741 | 695 | 650 | 607 | 569 | 532 | 499 | 470 | 444 | 421 | 400 |
| 4.25 | 988 | 986 | 982 | 975 | 963 | 946 | 924 | 895 | 860 | 820 | 776 | 731 | 686 | 642 | 602 | 564 | 530 | 500 | 472 | 447 | 425 |
| 4.50 | 992 | 991 | 988 | 982 | 973 | 960 | 941 | 916 | 886 | 849 | 808 | 765 | 720 | 677 | 635 | 596 | 561 | 529 | 500 | 474 | 450 |
| 4.75 | 995 | 993 | 992 | 988 | 981 | 971 | 955 | 935 | 908 | 875 | 838 | 797 | 753 | 710 | 668 | 628 | 591 | 558 | 527 | 500 | 475 |
| 5.00 | 997 | 996 | 995 | 992 | 987 | 979 | 967 | 950 | 927 | 898 | 864 | 826 | 785 | 742 | 700 | 660 | 622 | 587 | 555 | 526 | 500 |
| 5.25 | 998 | 998 | 997 | 995 | 991 | 985 | 975 | 962 | 943 | 918 | 888 | 853 | 814 | 772 | 731 | 690 | 651 | 615 | 582 | 552 | 525 |
| 5.50 | 999 | 999 | 998 | 996 | 994 | 989 | 982 | 971 | 956 | 935 | 908 | 877 | 840 | 801 | 760 | 720 | 681 | 644 | 610 | 578 | 550 |
| 5.75 | 999 | 999 | 999 | 998 | 996 | 993 | 987 | 979 | 966 | 949 | 926 | 898 | 865 | 828 | 789 | 749 | 709 | 672 | 637 | 604 | 575 |
| 6.00 | * | 999 | 999 | 998 | 997 | 995 | 991 | 985 | 975 | 961 | 941 | 917 | 887 | 853 | 815 | 776 | 737 | 700 | 664 | 630 | 600 |
| 6.25 | * | * | 999 | 999 | 998 | 997 | 994 | 989 | 981 | 970 | 954 | 933 | 907 | 875 | 840 | 803 | 764 | 727 | 690 | 656 | 624 |
| 6.50 | * | * | * | 999 | 999 | 998 | 996 | 992 | 987 | 978 | 965 | 947 | 924 | 896 | 863 | 828 | 790 | 753 | 716 | 681 | 649 |
| 6.75 | * | * | * | * | 999 | 999 | 997 | 995 | 990 | 984 | 973 | 958 | 939 | 914 | 884 | 851 | 815 | 778 | 740 | 706 | 673 |
| 7.00 | * | * | * | * | * | 999 | 998 | 996 | 993 | 988 | 980 | 968 | 951 | 930 | 903 | 872 | 838 | 803 | 767 | 731 | 697 |
| 7.25 | * | * | * | * | * | 999 | 999 | 998 | 995 | 991 | 985 | 976 | 962 | 943 | 920 | 892 | 860 | 826 | 791 | 755 | 721 |
| 7.50 | * | * | * | * | * | * | 999 | 998 | 997 | 994 | 989 | 982 | 970 | 955 | 935 | 910 | 880 | 848 | 814 | 779 | 745 |
| 7.75 | * | * | * | * | * | * | 999 | 999 | 998 | 996 | 992 | 987 | 978 | 965 | 947 | 925 | 899 | 868 | 836 | 802 | 768 |
| 8.00 | * | * | * | * | * | * | * | 999 | 999 | 997 | 995 | 990 | 983 | 973 | 958 | 939 | 915 | 887 | 856 | 824 | 790 |
| 8.25 | * | * | * | * | * | * | * | * | 999 | 998 | 996 | 993 | 988 | 979 | 967 | 951 | 930 | 905 | 876 | 844 | 812 |
| 8.50 | * | * | * | * | * | * | * | * | 999 | 999 | 997 | 995 | 991 | 985 | 975 | 961 | 943 | 920 | 894 | 864 | 832 |
| 8.75 | * | * | * | * | * | * | * | * | * | 999 | 998 | 997 | 994 | 989 | 981 | 969 | 954 | 934 | 910 | 882 | 852 |
| 9.00 | * | * | * | * | * | * | * | * | * | 999 | 999 | 998 | 995 | 992 | 986 | 976 | 963 | 946 | 925 | 899 | 871 |
| 9.25 | * | * | * | * | * | * | * | * | * | * | 999 | 998 | 997 | 994 | 989 | 982 | 971 | 957 | 938 | 915 | 888 |
| 9.50 | * | * | * | * | * | * | * | * | * | * | 999 | 999 | 998 | 996 | 992 | 987 | 978 | 966 | 949 | 929 | 904 |
| 9.75 | * | * | * | * | * | * | * | * | * | * | * | 999 | 999 | 997 | 995 | 990 | 983 | 973 | 959 | 941 | 919 |
| 10.0 | * | * | * | * | * | * | * | * | * | * | * | * | 999 | 998 | 996 | 993 | 987 | 979 | 967 | 952 | 932 |
| | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |

* Tabular entry is 1.000

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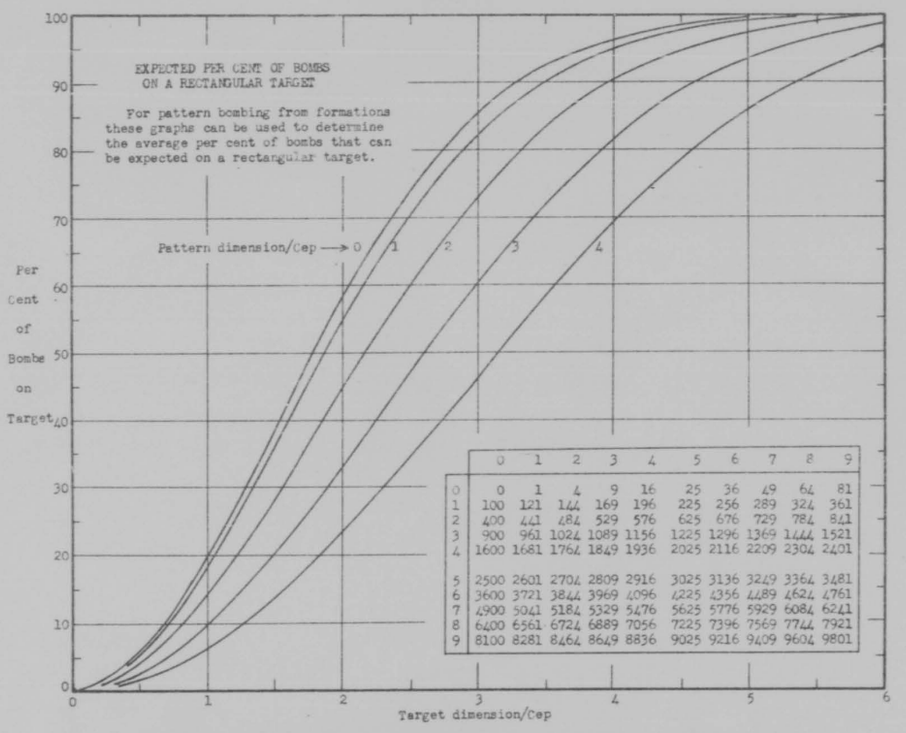



| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 4 | 9 | 16 | 25 | 36 | 49 | 64 | 81 |
| 1 | 100 | 121 | 144 | 169 | 196 | 225 | 256 | 289 | 324 | 361 |
| 2 | 400 | 441 | 484 | 529 | 576 | 625 | 676 | 729 | 784 | 841 |
| 3 | 900 | 961 | 1024 | 1089 | 1156 | 1225 | 1296 | 1369 | 1444 | 1521 |
| 4 | 1600 | 1681 | 1764 | 1849 | 1936 | 2025 | 2116 | 2209 | 2304 | 2401 |
| 5 | 2500 | 2601 | 2704 | 2809 | 2916 | 3025 | 3136 | 3249 | 3364 | 3481 |
| 6 | 3600 | 3721 | 3844 | 3969 | 4096 | 4225 | 4356 | 4489 | 4624 | 4761 |
| 7 | 4900 | 5041 | 5184 | 5329 | 5476 | 5625 | 5776 | 5929 | 6084 | 6241 |
| 8 | 6400 | 6561 | 6724 | 6889 | 7056 | 7225 | 7396 | 7569 | 7744 | 7921 |
| 9 | 8100 | 8281 | 8464 | 8649 | 8836 | 9025 | 9216 | 9409 | 9604 | 9801 |

The Cep used is the Cep of pattern centers, or 94% of the average radial aiming error of patterns.

When target and pattern are both squares: Find (a) target dimension/Cep and (b) pattern dimension/Cep. Enter the baseline with figure (a) and read the result from the curve corresponding to figure (b). If figure (b) is not equal to 0, 1, 2, 3, or 4, estimate the result from the two nearest curves corresponding to numbers on either side of (b).

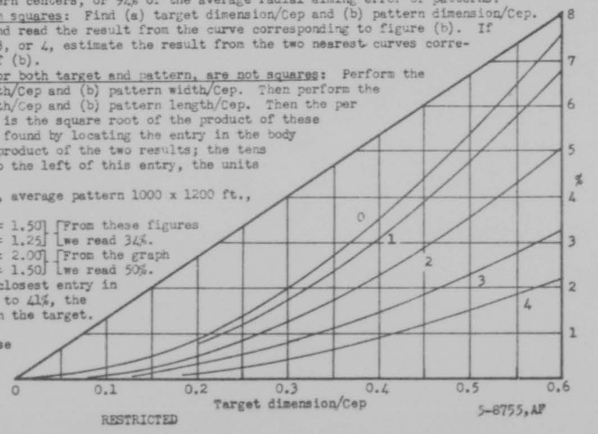
When either target or pattern, or both target and pattern, are not squares: Perform the above operation using (a) target width/Cep and (b) pattern width/Cep. Then perform the same operation using (a) target length/Cep and (b) pattern length/Cep. Then the per cent of bombs expected on the target is the square root of the product of these two results. The square root can be found by locating the entry in the body of the table that is closest to the product of the two results; the tens digit of the final result will lie to the left of this entry, the units digit will lie above the entry.

Example: Given Cep = 800 ft., average pattern 1000 x 1200 ft., and a target 1200 x 1600 ft.

Target width/Cep = 1200/800 = 1.50 ] From these figures
Pattern width/Cep = 1000/800 = 1.25 ] we read 34%.
Target length/Cep = 1600/800 = 2.00 ] From the graph
Pattern length/Cep = 1200/800 = 1.50 ] we read 50%.

Then 34 x 50 = 1700, and the closest entry in the table is 1681, which corresponds to 41%, the per cent of bombs expected to fall on the target.

The graph at the right is for use with small target dimensions.

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OPERATIONS ANALYSIS REPORT

Issuing Unit: Operations Analysis Division
Twentieth Air Force

Title: VISUAL BOMBING THROUGH PARTIAL CLOUD COVER

Date: 10 April 1945

Identification: Report dated 10 April 1945

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HEADQUARTERS, TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

WASHINGTON, D. C.

10 April 1945

# VISUAL BOMBING THROUGH PARTIAL CLOUD COVER

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VISUAL BOMBING THROUGH PARTIAL CLOUD COVER

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## SUMMARY

1. Practical experience and theoretical considerations show that visual bombing runs can be expected with assurance only when cloudiness over the target is 2/10 or less. Over the important Japanese targets, days with 2/10 cloudiness or less are scarce between March and October (Tokyo: 1-4 days per month). There are, however, 3 to 5 additional days per month when 3 to 7/10 cloudiness prevails.

2. These days with scattered to broken clouds can be exploited for visual bombing more successfully if these points are considered:

a. Substantial increases in the probability that a formation will have a visual bombing run can be achieved if more than one bombing run is attempted.

b. For a high priority pin-point target, the elimination of which requires only a small bombload, a given force split into many small formations will have a much larger probability that a few formations will get visual runs than the same force split into a few large formations. Repeated bombing runs will still further increase the probabilities.

3. This report gives the probability that a formation will have a visual bombing run for cloud covers from 1 to 9/10 as a function of the weather conditions expected over the target and the expected mechanical operational data. The theory behind the results is given in full.

## I. INTRODUCTION

1. Visual daylight precision bombing is one of the most effective applications of strategic airpower. It provides one of the best means of eliminating strategic small-area and pin-point targets far behind enemy lines. In many areas clouds severely limit the frequency of high level visual bombing attacks. This is especially true of targets in the Japanese Empire, which is located in a weather zone where abundant cloudiness is prevalent.

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2. According to past experience, visual bombing runs are virtually certain with a cloud cover of 2/10 or less, while they are highly improbable for cloud covers of 8/10 or more. The probability that, for a given amount of cloud cover, a bombing run will be visual has been estimated in a Technical Paper by the Ninth Air Force Weather Service.* The present report is based on this paper. It will emphasize the opportunities for visual runs afforded by cloud covers between 3 and 7/10, provided the appropriate tactics are employed.

3. These intermediate cloud covers constitute a substantial proportion of observed cloud covers. For example, at 1400 hours Tokyo has the following average percentage of cases in the 3 - 7/10 group:

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 17 | 14 | 12 | 14 | 15 | 15 | 24 | 18 | 14 | 14 | 12 |

This table indicates that in every month of the year there are at least 3 days with 3-7/10 cloud cover; August has as many as 7 days. During the winter months, when Tokyo has 10 to 15 days per month with sky cover 2/10 or less at 1400 hours, the days with 3-7/10 cover are not too important, because sufficient opportunities for visual bombing are already available. On the other hand, during the month of June, which has only two days with cloudiness of 2/10 or less at 1400 hours, the possible 4 to 5 additional days with 3-7/10 cover would constitute a significant factor if they could be exploited for visual bombing.

4. The probability figures given in this report will indicate that these days can be used for visual bombing in a great number of cases, especially when discrete clouds are encountered, such as:

a. cumulus,

b. fractocumulus,

c. scattered stratocumulus, and

d. altocumulus.

---

*Probability of Cloud Obstructing Vision during Bombing Run, Ninth Air Force Weather Service Technical Paper No. 3, dated 10 November 1944, by Major N. Allen Riley, Staff Weather Officer, IX Bombardment Division.



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According to Japanese cloud observations near Tokyo, in June, for example, 85% of the cloud types with 3-7/10 cover are in these cloud categories; in other months these four types constitute 60% or more of the observed cloud types.

## II. CONCLUSIONS

1. In order to get an estimate of the probability of obtaining a visual bombing run over a layer of scattered or broken clouds, it is necessary to have at hand the following information:

a. Weather at the Target

(1) Expected cloudiness in tenths.

(2) Approximate height of the cloud layer, measured to a point halfway between the bases and the tops.

(3) Approximate thickness of the cloud layer.

(4) Windspeed and direction at the bombing altitude.

(5) Expected cloud type; i.e. either

(a) cumulus,

(b) fractocumulus,

(c) scattered stratocumulus, or

(d) altocumulus.

since the theory on which this report is based refers only to these types.

b. Operational Data

(1) Bombing altitude.

(2) Bombing airspeed.

(3) Axis of attack.

(4) Types of bombs to be loaded.

(5) Expected duration of bombing run.

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2. Many of these quantities can be predicted in advance of the bombing run only in an approximate way, and therefore the probability values given in this report are in the nature of estimates. Also, in order to make the situation amenable to a reasonably simple analysis, certain fairly formalized assumptions are made, which can also be realized only approximately in practice. In spite of these qualifications, many general conclusions can be reached which are realistic.

3. As a result of this study these conclusions can be stated for high level bombing:

a. The probability that a single bombing run will be visual is 50% or greater only when cloudiness is 4/10 or less. Probabilities of 50% or greater will occur only under very restricted conditions when cloudiness is 4/10; restrictions are much less stringent when cloudiness is 3/10 or less. Thus a 50% or better chance of making a visual bombing run from a high altitude can be reasonably expected only when cloudiness is 3/10 or less. Experience shows that very little difficulty in making visual runs is encountered when cloudiness is 2/10 or less.

b. Very substantial increases in probabilities can be achieved if the tactical situation permits more than one bombing run. Under some combinations of conditions, with cloud cover up to 5/10, and even 6/10, the probability that at least one of two runs will be visual is 50% or better. Under some conditions of 7/10 cover the probability that one of three runs will be visual is 50% or better. With repeated bombing runs, corresponding increases up to almost certainty can be expected for cloudiness of 4/10 and less.

c. When a small area or pin-point target is attacked under partly cloudy conditions and it is desirable on a single attack to place at least a few bombs on the target, substantial increases in the probability of at least one visual run will accrue if the force is split into many small formations, and these formations are fairly widely spaced over the target. For example, if a single formation has only a 20% chance of making a visual run, two twelve-plane formations have a 36% probability that at least one formation will have a visual run; but if six four-plane formations are run, there is a 74% probability that at least one formation will have a visual run. Thus, there is a fairly large expectation of getting at least one visual run under 6/10 and 7/10 cloudiness, if many small formations are flown.

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d. For targets which are to be attacked repeatedly under fairly uniform conditions of cloudiness, no theoretical advantage will be secured from splitting up the formations. While more of the smaller formations will have visual runs, over a long period the portion of the total bombload that will be dropped visually is the same.

e. The small probability that a formation will get a visual run when cloud cover is 4/10 or more, points to the urgent necessity for very accurate prediction of the weather over Japanese targets, especially during the Summer months. During the summer it is essential that all of the few days with 2/10 cloudiness or less be fully exploited. Further, it is necessary, in order to take full advantage of those when cloudiness is 3-7/10, to tailor tactics to the expected cloud conditions.

f. The effects of changes of several variables upon the probability of obtaining a visual run are worth noting:

The probability of obtaining a visual run increases as:

(1) The bombing altitude increases.

(2) The height of the cloud layer decreases.

(3) The thickness of the cloud layer decreases.

(4) The groundspeed decreases. (Thus the greatest probability of a visual run is achieved when the bombing run is upwind, although this is probably impractical in many cases).

(5) The bombing run decreases in length. (This decrease is fairly small at high altitudes. It is probably unwise to sacrifice the greater accuracy of the longer bombing run in order to obtain this advantage)

## III. PROCEDURE USED IN COMPUTING THE PROBABILITY

1. The various factors entering into the computation, the notations for them, and how they are computed, follow:

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G = expected groundspeed in miles per hour of the bomber during the bombing run. This quantity can be computed from the planned axis of attack, the expected bombing airspeed, and the windspeed and direction forecast for the bombing altitude over the target.

T = expected duration of bombing run in minutes. (Choose the smallest figure that will give a good bombing run.)

L = expected length of the bombing run in miles. Obviously

$$L = GT/60.$$

R = range of the bombs, i. e., the horizontal distance in miles between bomb release point and the target. This quantity depends upon the type of bomb to be dropped, and can be determined from ballistic tables when the airspeed, wind velocity, and bombing altitude are known.

H = planned bombing altitude in feet.

h = forecast cloud altitude in feet, measured to a point half-way between the bases and the tops.

t = forecast cloud thickness in feet

C = cloud opening in miles necessary for a visual run on the target. This quantity is given by the formula:

$$C = Lh/H + (R + L/2)\ (t/H).$$

which is developed in Section IV.

D = cloud diameters in miles. This figure must be estimated from the expected cloud type. Unfortunately no systematic survey of cloud diameters is available from any source. However, estimates by experienced observers from cloud photographs yield the following data:

(a) Altocumulus (of discrete type): An average diameter of 600 to 700 feet (0.11 to 0.13 miles) can be assumed, although diameters may actually vary from 30 to 3000 feet.

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(b) Cumulus (of humilis and not congestus variety): 1300 feet (0.25 miles).

(c) Fractocumulus: Smaller than cumulus, but diameters may vary from 25 to 1300 feet.

(d) Stratocumulus (scattered): From 1500 to 2600 feet (0.28 to 0.50 miles)

Experience and further study should refine these estimates.

N = forecast cloud cover in tenths.

F = cloud frequency factor. When N and D are known, F can be determined from Fig. 2

S = cloud spacing factor. This quantity is given by the formula:

$$S = FC$$

P = % probability of obtaining a visual run on the target. When N and S are known, P can be obtained from Table 1, or from Fig. 3 which is a graph of the data in Table 1.

2. When the probability that a single run will be visual is known, we can find the probability that one or more of several repeated runs will be visual. These figures are tabulated in Table 2 and shown graphically in Fig. 4. These figures can also be construed as giving the probability that one or more of several attacking formations will have visual runs.

3. When two cloud layers are present, the percent probability of obtaining a visual run can be computed for each layer separately. If $P_1$ is the percent probability for the first layer, and $P_2$ is the percent probability for the second layer, then the percent probability of obtaining a visual run over both cloud layers is:

$$P_1 P_2/100$$

Example: Target X is to be attacked. The weather forecast is for 3/10 cover of stratocumulus with bases at 4000 and tops at 6000, and a wind of 30 knots from 280° at the bombing altitude of 25,000 feet. The axis of attack is to be 33°, and the probable true airspeed on the bombing run will be 190 m.p.h. It is ex-



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pected that a 45 second bombing run will be satisfactory. The planes will carry 500# G.P. M-64 bombs.

Find:

(a) the probability that a single bombrun will be visual,

(b) the probability that at least one of two bombruns will be visual, and

(c) the probability that at least one of six formations will have a visual bombrun

The usual vector velocity diagram yields G = 200 m.p.h. Since T = 0.75 min., we have

$$L = 200\ (0.75)\ /60 = 2.5 \text{ miles.}$$

From ballistic tables we find that R = 2.2 miles, approximately. Since

H = 25,000 feet
h = 5,000 feet
t = 2,000 feet

we have:

$$C = 2.5\ (5000)/25000 + (2.2 + 2.5/2)(2000/25000)$$

$$= 0.78 \text{ miles.}$$

Using D = 0.5, we find from Fig. 2 that F = 1.35, whence

$$S = 1.35\ (0.78) = 1.05.$$

With S = 1.05 and N = 3/10, we find from Fig. 3 that there is a 34% probability that a bombing run will be visual. From Table 2 the probability that at least one of two bombruns will be visual is 56%, and the probability that at least one of six formations will have a visual run is 91%.

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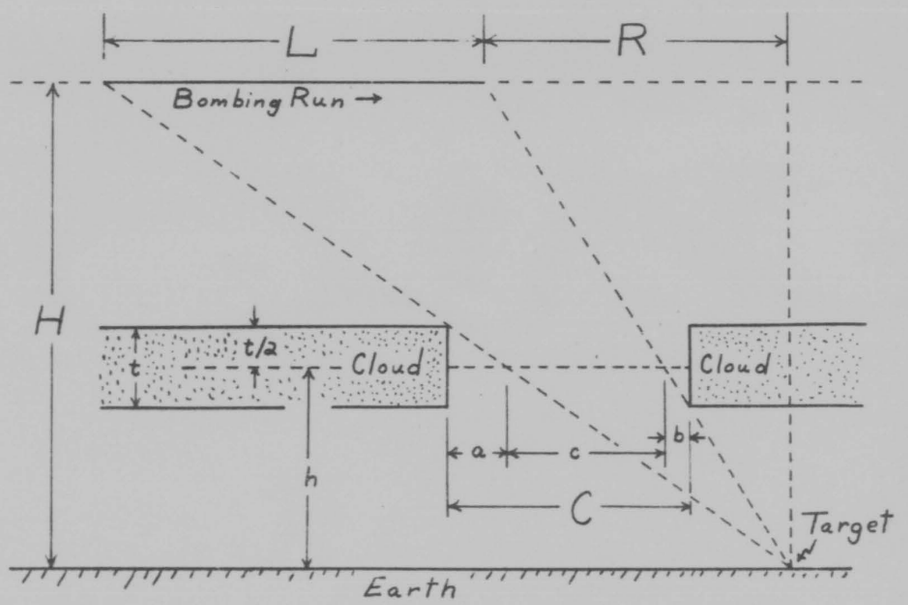


Fig. 1. Visual bombing run over a cloud opening.

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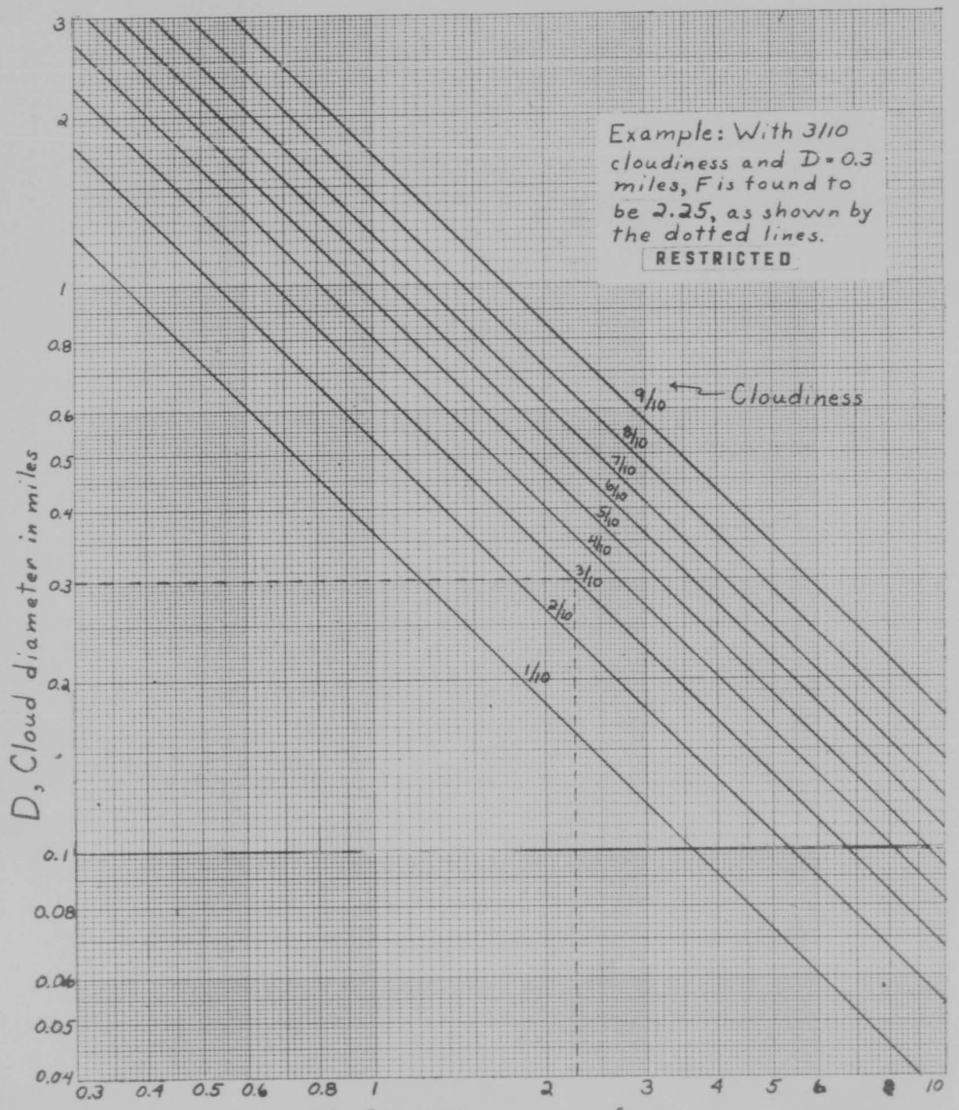


Fig. 2

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Table 1. Per cent probability P of obtaining a visual bombing run as a function of cloudiness N and cloud spacing factor S.

| | Cloud spacing factor S | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.75 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| 1/10 | 90.0 | 86.8 | 83.6 | 80.6 | 77.7 | 74.9 | 68.4 | 62.4 | 52.0 | 43.2 | 36.1 | 30.0 |
| 2/10 | 80.0 | 75.8 | 71.9 | 68.2 | 64.6 | 61.2 | 53.7 | 47.0 | 35.9 | 27.6 | 21.2 | 16.2 |
| 3/10 | 70.0 | 65.5 | 61.2 | 57.2 | 53.3 | 49.7 | 41.9 | 35.3 | 25.1 | 17.8 | 13.0 | 9.2 |
| 4/10 | 60.0 | 55.3 | 51.0 | 47.1 | 43.5 | 40.3 | 32.8 | 26.9 | 18.0 | 12.0 | 8.0 | 5.3 |
| 5/10 | 50.0 | 45.5 | 41.4 | 37.7 | 34.3 | 31.2 | 24.1 | 19.5 | 12.3 | 7.6 | 4.8 | 3.0 |
| 6/10 | 40.0 | 35.9 | 32.2 | 28.9 | 26.0 | 23.3 | 17.8 | 13.6 | 7.9 | 4.6 | 2.7 | 1.5 |
| 7/10 | 30.0 | 26.5 | 23.4 | 20.7 | 18.2 | 16.1 | 11.8 | 8.7 | 4.7 | 2.5 | 1.4 | 0.7 |
| 8/10 | 20.0 | 17.3 | 15.0 | 13.0 | 11.3 | 9.8 | 6.8 | 4.8 | 2.3 | 1.2 | 0.6 | 0.3 |
| 9/10 | 10.0 | 8.4 | 7.1 | 6.0 | 5.0 | 4.2 | 2.8 | 1.8 | 0.8 | 0.3 | 0.2 | 0.1 |

Table 2. Per cent probability that one or more of several bombing runs will be visual as a function of the probability that a single bombing run will be visual.

| | | Number of bombing runs | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | 3 | 4 | 5 | 6 | 10 |
| Per cent probability that a single bombing run will be visual | 5 | 9.8 | 14.3 | 18.5 | 23.3 | 26.5 | 40.2 |
| | 10 | 19.0 | 27.1 | 34.4 | 41.0 | 46.9 | 65.2 |
| | 15 | 27.8 | 38.7 | 47.8 | 55.6 | 62.2 | 80.3 |
| | 20 | 36.0 | 48.8 | 59.0 | 67.2 | 73.8 | 89.3 |
| | 25 | 43.8 | 57.8 | 68.4 | 76.3 | 82.2 | 94.4 |
| | 30 | 51.0 | 65.7 | 76.0 | 83.2 | 88.2 | 97.2 |
| | 35 | 57.8 | 72.6 | 82.2 | 88.4 | 92.5 | 98.6 |
| | 40 | 64.0 | 78.4 | 87.5 | 92.2 | 95.3 | 99.4 |
| | 45 | 69.8 | 83.4 | 90.9 | 95.0 | 97.2 | 99.7 |
| | 50 | 75.0 | 87.5 | 93.8 | 96.9 | 98.4 | 99.9 |
| | 55 | 79.8 | 90.9 | 95.9 | 98.2 | 99.2 | * |
| | 60 | 84.0 | 93.6 | 97.4 | 99.0 | 99.6 | * |
| | 65 | 87.8 | 95.7 | 98.5 | 99.5 | 99.8 | * |
| | 70 | 91.0 | 97.3 | 99.2 | 99.8 | * | * |
| | 75 | 93.8 | 98.4 | 99.6 | 99.9 | * | * |
| | 80 | 96.0 | 99.2 | 99.8 | * | * | * |
| | 85 | 97.8 | 99.7 | * | * | * | * |
| | 90 | 99.0 | 99.9 | * | * | * | * |

* Greater than 99.9%



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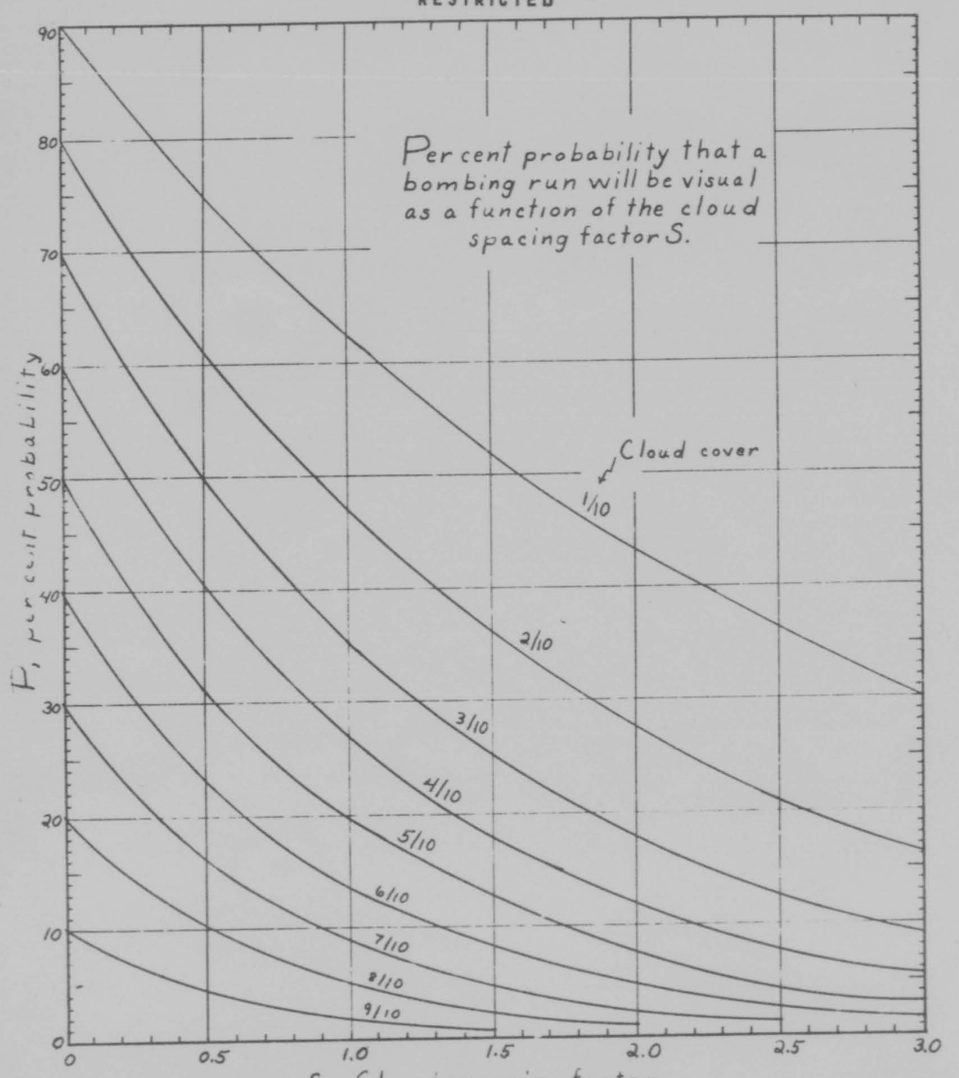


Fig. 3.

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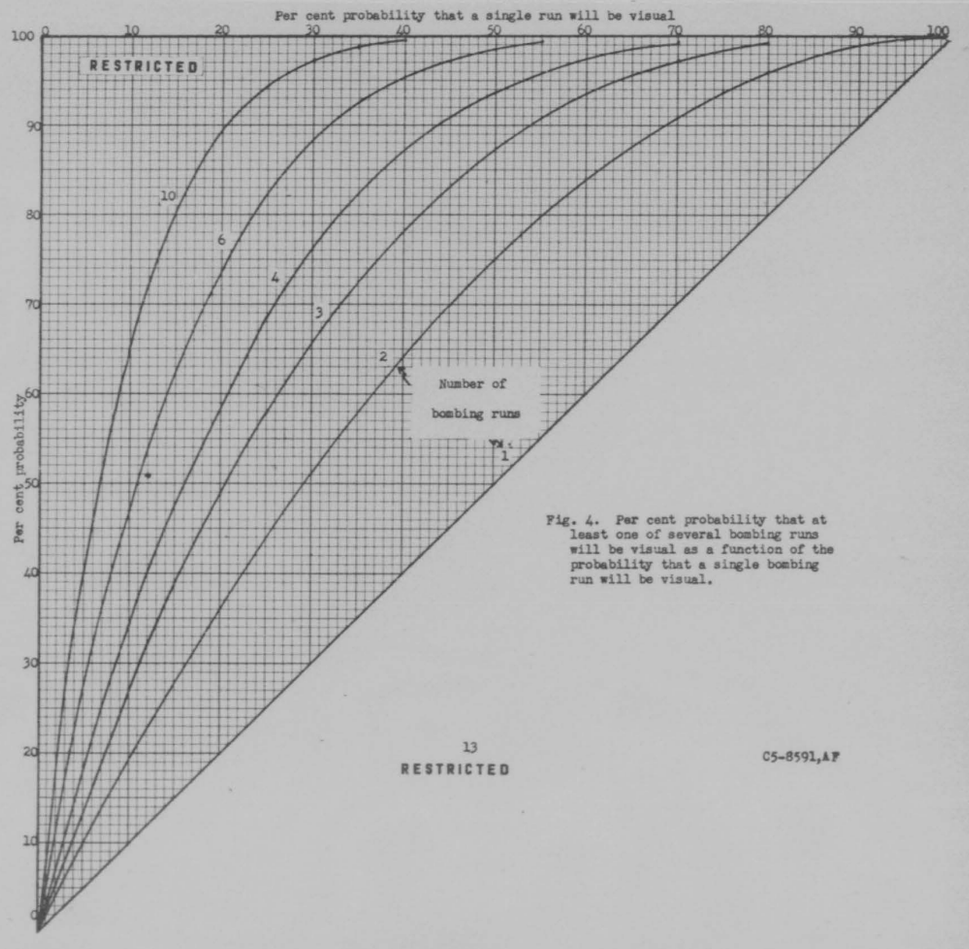


Fig. 4. Per cent probability that at least one of several bombing runs will be visual as a function of the probability that a single bombing run will be visual.



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## IV. DEVELOPMENT OF THE THEORY

1. We shall first find the length of opening C in the clouds necessary if a bombrun of length L is to be made visually. The geometrical situation is that of Fig. 1. From this figure we have:

$$C = a + b + c$$

and

$$a = t(R + L)/2H\,, \quad b = tR/2H\,, \quad c = Lh/H,$$

whence

(1) $$C = Lh/H + (R + L/2)(t/H).$$

We shall assume that the clouds are circular disks of uniform size, with diameter D. Then, if we are to have a visual bombrun of length L, no cloud center may enter an area, properly located over the target, of the size and shape shown in Fig. 5.

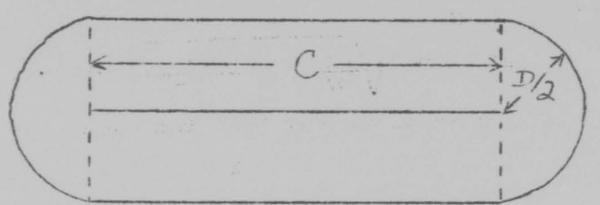


Fig. 5.

The area A of the configuration shown in Fig. 5 is

(2) $$A = CD + \pi D^2/4$$

Consider now some very large area of size A* centered on the target area, containing n cloud disks. Then if x is the average number of cloud disks per unit of area, $x = n/A^*$. If we assume it to be equally likely that a given cloud be at any specified position in A*, then the probability that any given cloud center will lie in A is $A/A^*$. Hence the probability that the center of the given cloud will not lie in A is $1 - A/A^*$. The probability P that a visual run of length L will be obtained is the probability that none of the n clouds will have center in A, or

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(3) $$P = (1 - A/A^*)^n = (1 - xA/n)^n .$$

Since $A^*$ and n are assumed to be very large, it follows that $e^{-xA}$, where $e = 2.71828\ldots$, can be used as a good approximation to the expression $(1 - xA/n)^n$. Then the probability P of obtaining a visual bombrun of length L is

(4) $$P = e^{-xA} = e^{-x(CD + \pi D^2/4)} = e^{-xCD} \cdot e^{-x\pi D^2/4} .$$

The probability that a point chosen at random will be free of cloud cover is

(5) $$1 - N = e^{-x\pi D^2/4}$$

which is also the probability that no cloud will have center in a disk of area A with center at the given point. Combining (4) and (5) we have

(6) $$P = (1 - N)\, e^{-xCD} .$$

From (5) we obtain

(7) $$\sqrt{x} \cdot D = 2\sqrt{\frac{1}{\pi} \log_e \frac{1}{1 - N}} = k .$$

Values of k for various values of N are given below:

| N | k |
|---|---|
| 1/10 | 0.3662 |
| 2/10 | 0.5330 |
| 3/10 | 0.6742 |
| 4/10 | 0.8067 |
| 5/10 | 0.9395 |
| 6/10 | 1.0803 |
| 7/10 | 1.2383 |
| 8/10 | 1.4317 |
| 9/10 | 1.7123 |

Combining (6) and (7) we have

(8) $$P = (1 - N)\, e^{-\sqrt{x}\,Ck} .$$

If we let $F = \sqrt{x}$, and $S = \sqrt{x} \cdot C = FC$, then

(9) $$P = (1 - N) \cdot e^{-kS}$$



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If the probability is expressed as per cent, then

(10) $$P = 100\,(1 - N)\,e^{-kS}\,.$$

Table 1 and Fig. 3 were made from formula (10). Fig. 2 was drawn from formula (7).

2. If P is the per cent probability that a bombing run will be visual, then the per cent probability that such a bombing run will not be visual is 100 (1 - P/100), and the per cent probability that none of m such bombing runs will be visual is $100\,(1 - P/100)^m$. Finally, if P is the per cent probability that a bombing run will be visual, then the per cent probability that one or more of m such runs will be visual is

(11) $$100\left[1 - (1 - P/100)^m\right]\,.$$

Table 2 and Fig. 4 were made from formula (11).

## V. DISCUSSION OF THE THEORY

1. The theory is based, as we have seen, on certain formal assumptions, adopted in order to make the situation amenable to a reasonably simple mathematical treatment. It is assumed that the clouds are circular disks of uniform size, so that a diameter can be estimated for them. Most clouds, of course, vary in size and are irregular in shape, so that this approximation is very crude. Because the geometry of cloud shapes is so varied and complicated, it is felt that no better reasonably simple mathematical assumption can be made. Also, estimates of cloud diameters D and cloud densities x made from cloud photographs yield values that in the majority of cases check with formula (7) very well. This indicates that a more or less random variation from the assumed model prevails, and tends to support the feeling that the theoretical model chosen is adequate for the deviation of the probability of obtaining a visual run.

2. The theory is developed in the same way it would have been developed if pennies were pitched on a large table top, it being equally probable that a penny land on any given part of the table top. When a considerable portion of the table top is covered by pennies (say 4/10 or more), many pennies will overlap others. The pennies correspond to the cloud disks in our theory.

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However, when two clouds "overlap", we usually consider them as one cloud. If D is measured from a sort of an average size detached cloud in a layer, the larger clouds can be thought of as corresponding to overlapping smaller clouds. Thus the model is reasonably realistic on this score. As a result of this situation, the values of x found from (7) will tend to be slightly larger than densities x actually estimated from photographs, especially for higher cloudinesses.

3. Experience shows that the probability estimates derived from the theory given in this report are often on the pessimistic side. However, an error on the conservative side cannot affect the qualitative conclusions in the report. In short, it is believed that the conclusions and probabilities developed in this report are realistic, the quantitative estimates having a slight tendency to err on the conservative side.

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AN ANALYSIS OF THE PRACTICE RADAR BOMBING
AT THE LEAD CREW SCHOOL
19-31 May 1945.

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SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1. The present report gives an analysis of practice radar bombing for the first twelve crews assigned to the course at the Lead Crew School at Spokane, Washington. While the 249 radar bombing exercises that were scored give an adequate basis for some conclusions, they furnish scanty evidence for others, especially in estimates of analysis of crew progress. Consequently, this report must be regarded more as an attempt to apply certain suggested methods to the analysis of practice bombing scores than as an attempt to assess the value of Lead Crew training, or to evaluate the progress of crews during the training. Only by an analysis of a much larger body of evidence supplied by later classes can we hope to achieve more quantitive estimate of the value of special Lead Crew Training.

2. The report shows that it is practical and fair to separate circular aiming errors into two categories, normal aiming and gross errors, and establishes 5000 feet as a dividing line between these two classes of errors. It is suggested that this boundary be adopted for the next class, subject to revision as additional evidence is gained.

3. In spite of targets of increasing difficulty for the most part, the school as a whole, and most crews have shown progress in bombing accuracy.

4. A method of combining the proportion of gross errors with the average circular error of normal aimings is given that enables one, by computing a theoretical per cent of bombs on a target, to give in a single figure a direct estimate of the bombardment effectiveness of a crew, or any combination of crews.

5. Data are presented for the school as a whole, and for individual crews.

6. It is recommended that statistical analyses be made of radar bombing accuracy records at the end of the training of each class. They should provide valuable data for judging the effectiveness in bombing accuracy of the Lead Crew School, and they should provide also a valuable guide for the school itself as to what standards it can reasonably maintain and what goals it can reasonably set itself.

SEPARATION OF NORMAL AIMINGS FROM GROSS ERRORS

1. The distribution of the circular errors of the assessed radar aiming operations for the period 19-31 May at the Lead Crew School is shown in Fig. 1. It seems reasonable to assume that the distribution of these errors is a circular normal distribution, since this assumption is made for visual aiming operations in the Handbook for Bombardiers, TM I-251, (1), and since the Eighth Air Force Operational Research Section has found that this assumption is not approximately

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in visual combat aiming operations (2). However, if we fit a curve based on this assumption to all of the data (3), we find that the fitted curve seems to lie too far to the right. If we inspect the distribution more carefully, we see that a curve of the proper shape should fit rather closely to the distribution of the circular errors that are less than 6000 feet if these circular errors are considered separately. When a curve is fitted in this way (4), we see that this is indeed the case.

2. The question then arises: Why do the circular errors less than 6000 feet seem to fit the usual assumption better than all of the circular errors? A clue to the answer to this question was found in the feeling of some of the instructors in the Lead Crew School that the circular errors of some aimings are due to the inevitable collection of small errors in the operation, and that the errors of other aimings are the result of major personnel failures, such as misidentification of the target, use of incorrect data, etc. If this feeling is correct, then the distribution of circular errors shown in Fig. 1 may be regarded as the sum of two separate distributions, viz:

a. Normal Aimings: Those errors normally to be expected, due to the inevitable errors that creep into the radar aiming operation.

b. Gross Errors: Those errors due to some major personnel failure in the operation of the equipment.

The normal aimings should form a circular normal distribution, while the gross errors could hardly be expected to do so. Since the aimings less than 6000 feet in error were seen to fit this assumption very closely, 6000 feet was chosen as the borderline between normal aimings and gross errors. Then for the Lead Crew School we define:

a. Normal Aiming: An aiming less than 6000 feet in error.

b. Gross Errors: An aiming more than 6000 feet in error (5).

This choice enables one in the analysis of individual crew scores, as well as combined school records, to focus attention on two separate aspects of crew training, the refinement of normal procedures, and the elimination of personnel errors. One very bad error is thus not allowed to increase unduly the average circular error of a crew.

In future classes it may be possible to reduce the dividing line between gross errors and normal aimings to 5000 feet, and even to 4000 feet, particularly in the last week or two of training.

RECORD OF THE LEAD CREW SCHOOL AS A WHOLE

1. For the period 13-31 May, the overall record of the Lead Crew School was as follows:

| | | |
|---|---|---|
| Number of scored aimings: | 293 | |
| Normal Aimings: | 220 | (75%) |
| Gross Errors: | 73 | (25%) |
| Average C.E. of normal aimings: | 2619 feet. | |



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2. This record includes only runs made purely by radar, and scored by photographic means. Many runs were made which could not be scored because of cloud cover, camera malfunction, etc. No account is taken in this analysis of these runs; it would be very difficult to say whether or not they should be counted for or against the crews concerned.

THE PER CENT OF BOMBS ON THE TARGET

1. It is of interest to see what proportion of bombs would have hit a target 3000 feet square if we assume that each of the crews was leading a formation that dropped a pattern 2000 feet square. Figure 2 shows a curve from which this percentage can be read as well as a table in which the same data is given (6). From this data we compute that 26.2% of all the bombs dropped as a result of normal aimings would have hit the assumed target. None of the bombs dropped with cross errors would, of course, have hit the target. To find the percent of bombs carried on all scored runs that would have hit the target, we need only multiply 26.2% by the proportion of scored runs that were normal aimings, viz., 75%. Then 75% of 26.2% is 19.7%. This latter figure has the advantage of giving a measure of the combined effect of cross errors and the average circular error of normal aimings.

2. In order to assess the progress of the Lead Crew School as a whole, Table 1 was prepared. This table shows a small decrease in cross errors, average circular error, and an increase in percent of bombs on the target in spite of the more difficult targets attacked in the later period.

RECORD OF THE LEAD CREW SCHOOL ON VARIOUS TARGETS ATTACKED

1. Table 2 shows the performance of the crews on the targets assigned for major attacks by radar. A few radar aimings on other targets are omitted from this assessment. This table also gives a chronological history of the school performance.

OVERALL RECORDS OF THE INDIVIDUAL CREWS

1. Table 3 shows the records for all scored aimings of each crew at the Lead Crew School. An instructive contrast can be drawn between crew 2 and crew 32. Although crew 32 has a smaller average C.E., crew 2, by holding its cross errors to a minimum, is able to place on the target a larger percent of the bombs it carries aloft.

COMPARISON OF EARLY AND LATE CREW RECORDS

1. Table 4 shows a comparison (for the same early and late periods used in Table 1) of the records of individual crews. While data on each crew is too scanty to make possible definite conclusions in most cases, some general conclusions can be drawn. For example, all but three crews have improved in overall bombing effectiveness, as shown by the last column of the table. One gets a general impression of crew progress from the table. Later classes should supply more data and give clearer indications. It should be noticed that it seems natural for a crew to raise its average C.E. slightly while reducing its cross errors, while at the same time improving its overall bombardment effectiveness as measured by the last column of Table 4.



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FOOT NOTES

(1) See pages 38-42.

(2) See a report of the Eighth Air Force Operational Research Section, dated 31 October 1943: Analysis of VIII Bomber Command Operations from the Point of View of Bombing Accuracy.

(3) The dotted line in Fig. 1.

(4) The solid line in Fig. 1.

(5) It is interesting to note that a similar analysis of Eighth Air Force visual aiming operations was made in the report referred to in Footnote (2), and the same conclusions were reached. The dividing line between normal aimings and gross errors for their visual combat operations was chosen as 3000 feet.

(6) This curve was constructed from the theory underlying the chart in two Air Force Manuals:

No. 67: How to Improve Formation Bombing, April 1945.

No. 79: Bombing Charts, April 1945.

The curve can, in fact, be constructed roughly from Chart 1 on page 5 of the second of these two manuals.

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Table 1.

RECORD OF 12 LEAD CREWS - LEAD CREW SCHOOL, 13-31 May 1945.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Period | No. of Scored Radar Runs | Gross Errors | Av. C.E. of Normal Airings | % of Normally Aimed Bombs on Target | % of All Bombs on Target | Targets |
| 14-19 May | 91 | 20(22%) | 2608 ft. | 26.5% | 20.6% | 4 easy<br>2 med. |
| 25-30 May | 90 | 11(12%) | 2595 ft. | 27.2% | 22.8% | 2 easy<br>3 med.<br>1 hard |

Explanation of Table 1

Column 1: 13 May was not used in the early period, because only a few attacks were made on the home air base. The period chosen, 14-19 May, included 3 flights by each crew at the school. The period 25-30 May likewise includes 3 flights by each crew. 31 May was not included because only fragmentary data was returned by crews. Scoring by anti-aircraft radar was planned but a last minute failure of ground communications prevented use of this means of scoring. Since 9-10/10 cloud cover was encountered only a few scattered runs could be scored from photographs. It is felt that inclusion in this table of such data would, therefore, be unfair to the crews, since it is not representative.

Column 5: Figures in this column were obtained from Figure 5.

Column 6: Figures in this column were obtained as described in the text, para three.

Column 7: Targets were rated in conversation with radar instructors as "hard", "medium", or "easy", according largely upon ease of identification on radar scope.

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TABLE 2 (Continued)

| TARGET | DATES | NO. OF SCORED RADAR RUNS | GROSS ECHOES | AVERAGE C.E. OF RADIAL ACCURACY | TARGET DIFFICULTY | REMARKS |
|---|---|---|---|---|---|---|
| Northrop | 21 May | 10 | 1 (6) | 2562 | Very Hard | (5-10/10 echoes. Only (a few scattered runs |
| L.A Steel | 31 May | 5 | 2 (10%) | 2442 | Mod to Hard | (scored. Northrop (have almost no return (on radar scope. |

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TABLE 2.

RECORD OF CREWS, LEAD CREW SCHOOL, 13-31 May 1945

| No. | Crew No. | Average C.E. of Normal Airdrops | No. of Scored Airdrops | Gross Errors | Rank by Gross Errors | % of normally aimed bombs on the target | Percent of all bombs carried on the target (Percent) | (Rank) |
|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 2000 | 25 | 5 (20%) | 6 | 38.8 | 21.1 | 1 |
| 2 | 5 | 2138 | 26 | 5 (19%) | 5 | 35.6 | 28.9 | 2 |
| 3 | 55 | 2352 | 37 | 13 (35%) | 11 | 31.0 | 20.8 | 5 |
| 4 | 54 | 2505 | 25 | 8 (32%) | 9 | 28.0 | 19.0 | 7 |
| 5 | 53 | 2576 | 30 | 5 (17%) | 3 | 26.9 | 22.3 | 3 |
| 6 | 52 | 2599 | 20 | 8 (40%) | 12 | 24.5 | 15.9 | 10 |
| 7 | 56 | 2701 | 21 | 6 (29%) | 7 | 24.9 | 17.7 | 8 |
| 8 | 51 | 2765 | 23 | 3 (13%) | 2 | 23.9 | 20.8 | 6 |
| 9 | 2 | 2848 | 20 | 1 (5%) | 1 | 22.9 | 21.8 | 4 |
| 10 | 6 | 2952 | 22 | 7 (32%) | 10 | 21.5 | 14.6 | 11 |
| 11 | 1 | 3001 | 24 | 4 (17%) | 4 | 20.9 | 17.3 | 9 |
| 12 | 3 | 3000 | 21 | 6 (29%) | 8 | 20.0 | 14.3 | 12 |

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TABLE 4.

COMPARISON OF THE EARLY AND LATE PERFORMANCE OF LEAD CREWS AT THE LEAD CREW SCHOOL
Early Period: 14-19 May
Late Period: 25-30 May

| Crew No. | Number of Scored Radar Runs | | Gross Errors | | Av. C.E. of Normal Aimings | | % of Normally Aimed Bombs on the Target | | Percent of all Bombs on the Target | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late |
| 1 | 7 | 6 | 2(29%) | 0(0%)* | 3073 | 3706 | 20.2 | 14.8 | 14.3 | 14.8* |
| 2 | 8 | 8 | 0(0%) | 0(0%)* | 2765 | 2607* | 23.9 | 26.4* | 23.9 | 26.4* |
| 3 | 11 | 0 | 3(27%) | - | 3492 | - | 16.4 | - | 16.4 | - |
| 4 | 8 | 7 | 0(0%) | 1 (14%) | 1722 | 1209* | 47.1 | 66.6* | 47.1 | 57.3* |
| 5 | 7 | 8 | 3(43%) | 1(13%)* | 2901 | 2793* | 23.2 | 23.5* | 12.7 | 20.6* |
| 6 | 7 | 9 | 2(29%) | 2(22%)* | 3979 | 2530* | 12.8 | 27.3* | 9.1 | 21.6* |
| 51 | 5 | 5 | 2(40%) | 0(0%)* | 2285 | 2681 | 30.4 | 25.2 | 13.2 | 25.2* |
| 52 | 6 | 4 | 3(50%) | 1(25%)* | 2112 | 1827* | 33.9 | 43.9* | 17.0 | 31.9* |
| 53 | 10 | 8 | 2(20%) | 0(0%)* | 2454 | 2793 | 29.0 | 23.5 | 23.2 | 23.5* |
| 54 | 7 | 6 | 2(29%) | 1(17%)* | 3210 | 1097* | 19.0 | 47.9* | 14.6 | 39.9* |
| 55 | 9 | 9 | 2(22%) | 4(44%) | 2711 | 2657 | 35.9 | 25.6 | 26.4 | 14.2 |
| 56 | 4 | 5 | 0(0%) | 2(40%) | 1285 | 3026 | 59.3 | 15.4 | 59.3 | 9.2 |

* Denotes improvement in the late period.

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DESCRIPTION OF TARGETS

Mission One:

1. The first mission is planned as a general mission to give an overall picture of the ability of the bombing team. Take-off is planned at 0500 hours. The aircraft flies a time-controlled mission from Muroc to Port Hueneme at 6,000 feet from which point the course is seaward and westerly for 300 miles. The aircraft then turns toward the Los Angeles target area and a climb is planned so as to be bing altitude of 30,000 feet is obtained 75 miles from the coastline. This approach allows the navigator and radar operator to compute a radar wind.

2. The Lockheed Aircraft Plant at Burbank, and the Kaiser Steel Mill at Fontana have been selected as targets for this first mission.

a. Both targets are near the coast on the landward side of industrial areas similar to the majority of Japanese targets.

b. As radar targets, the plants at Lockheed and Fontana are more difficult to identify than coastline targets with a sharp land water contact, but they do give sufficiently prominent returns to permit crews to make good radar runs while adapting themselves to the procedures taught in the school.

3. The overwater approach to the target is similar to overwater approaches to Japanese targets. Initial points are selected 30 to 40 miles from the target which makes the bomb run eight to ten minutes in duration.

Mission Two:

1. The second mission is to be from Muroc to the San Francisco area at 15,000 feet. The targets selected are industrial installations at San Bruno and the Naval facilities at Mare Island. The San Bruno target is a moderately difficult target and requires careful adjustment of tilt and gain. The Mare Island target is easily discernible and selected to allow crews to make procedure refinements.

Mission Three:

1. Mission Number Three is to the Los Angeles area on the North American Aircraft Plant at Municipal Airport and the Douglas Aircraft plant at Long Beach. Both targets are moderately difficult to identify on the scope and have been selected to show the crews that direct bombing may be made on industrial target with careful use of tilt and gain. The "L" shaped layout of the North American Plant can be distinctly seen with proper set operation, and a careful study of return relations in case Douglas Long Beach easily discernible. Bombing runs are to be made from Santa Catalina Island and Port Hueneme as initial points.

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Mission Four:

1. The fourth mission is at an altitude of 10,000 feet on three targets in the Los Angeles area. The North American and Douglas Long Beach targets of the previous mission are to be repeated to familiarize the crews with the different returns from different approaches and to allow them to make refinements in procedure. The Douglas plant at Clover has been selected as a new target. This target is much more difficult to identify than the other two.

Mission Five:

1. The fifth mission is to the San Francisco area at an altitude of 12,000 feet. All radar runs are made by the navigator on targets at Hunter Point and Pittsburg.

2. The Hunter Point target cannot be discerned until the last few miles of the run; however, the Hunter Point area is distinguishable at a great distance and the crews are briefed to live on their course on Hunter Point and then break down the target for identification just before release.

3. The Steel Mill at Pittsburg gives a large return and permits crews to continue emphasis on procedure refinements.

Sixth Mission:

1. The Vultee and Douglas aircraft plants are the targets for the sixth mission. Four runs are planned at 15,000 feet. Then these runs are scheduled on the Vultee plant at an altitude of 7,000 feet at an indicated air speed of 250 miles per hour.

2. These runs are designed to simulate the type of attack adopted in the recent night fire raids over Japanese cities.

3. Both targets give small radar returns and are the most difficult to identify of any thus far scheduled. They are planned in consideration of the possibility they precision targets will be the major objective after the present phase of area fire bombing is completed.

Seventh Mission:

1. The Seventh mission is at an altitude of 12,000 feet. The terrain will between Santa Clara and San Jose has been chosen as one of the targets. The route to the target passes over the Santa Cruz mountains and it has been chosen because of its similarity to Japanese terrain which are blocked by mountain approaches.

2. The San Leandro target is in Southern Oakland, directly east of the Oakland airport. The approach is made across San Francisco Bay and

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planned similar to approaches across Nagoya and Tokyo Bays. The target is difficult to locate and the crews are obliged to line up on the Oakland airport in order to properly sight the target.

Eighth Mission:

1. The eighth mission is planned as a long range navigation flight to Seattle and Portland. The flight to the target area consists of a six-hour time controlled leg over water before reaching the landfall point at an altitude of 16,000 feet. The navigators will be instructed to use all methods of celestial and dead reckoning navigation and will be prohibited from using radio aids unless an emergency develops.

2. The targets are the Seattle Boeing and Renton plants in Seattle and the Portland Air Terminal in Portland. The route to base is planned at 2,000 feet, and a radar run is to be made on the Chico Airport at Chico which is similar to airfields attacked in Kyushu.

Ninth Mission:

1. The ninth mission is again scheduled for the San Francisco area. Radar bomb runs are at 16,000 feet on an industrial plant at Sunnyvale and an oil refining unit at Richmond.

2. The Sunnyvale target is difficult to distinguish from the urban area, but crews are to be instructed to pick out the southeast corner

3. The Richmond target lies in the refinery region of that area and requires the crew to distinguish it from several similar target returns.

Tenth Mission:

1. On the tenth mission it is planned to repeat one of the first targets at Lockheed in order to obtain an indication of crew improvement in bombing procedure. The other target selection is in the center of the Los Angeles business district and requires the most careful adjustment of tilt and gain. It is believed that a demonstration of proficiency on these targets will indicate the ability to hit radar targets in the Japanese area.

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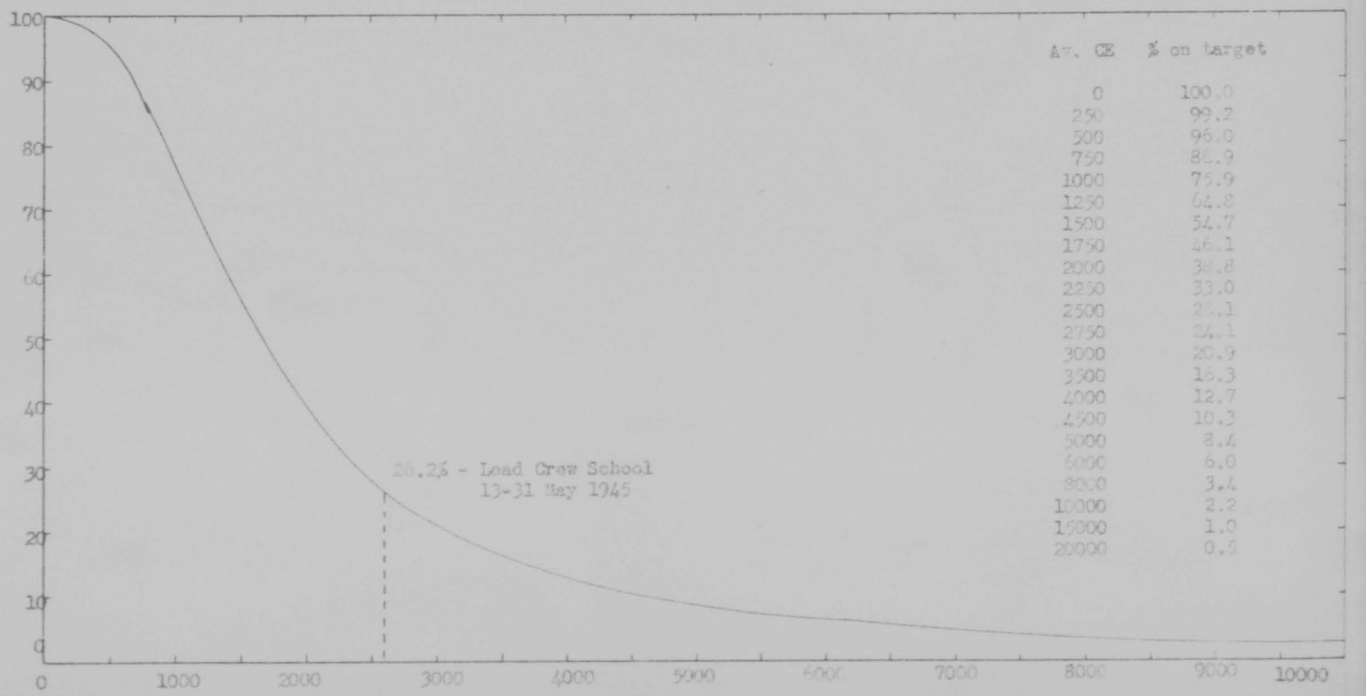
PER CENT OF BOMBS EXPECTED ON A TARGET

Pattern: 2000 ft. by 2000 ft.
Target: 3000 ft. by 3000 ft.




| Av. CE | % on target |
|---|---|
| 0 | 100.0 |
| 250 | 99.2 |
| 500 | 96.0 |
| 750 | 86.9 |
| 1000 | 75.9 |
| 1250 | 64.8 |
| 1500 | 54.7 |
| 1750 | 46.1 |
| 2000 | 38.8 |
| 2250 | 33.0 |
| 2500 | 28.1 |
| 2750 | 24.1 |
| 3000 | 20.9 |
| 3500 | 16.3 |
| 4000 | 12.7 |
| 4500 | 10.3 |
| 5000 | 8.4 |
| 6000 | 6.0 |
| 8000 | 3.4 |
| 10000 | 2.2 |
| 15000 | 1.0 |
| 20000 | 0.5 |

Average Circular Error
FIGURE 2.

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DISTRIBUTION OF CIRCULAR ERRORS OF RADAR BOMBING

LEAD CREW SCHOOL, 13-31 MAY 1945

(293 CASES)

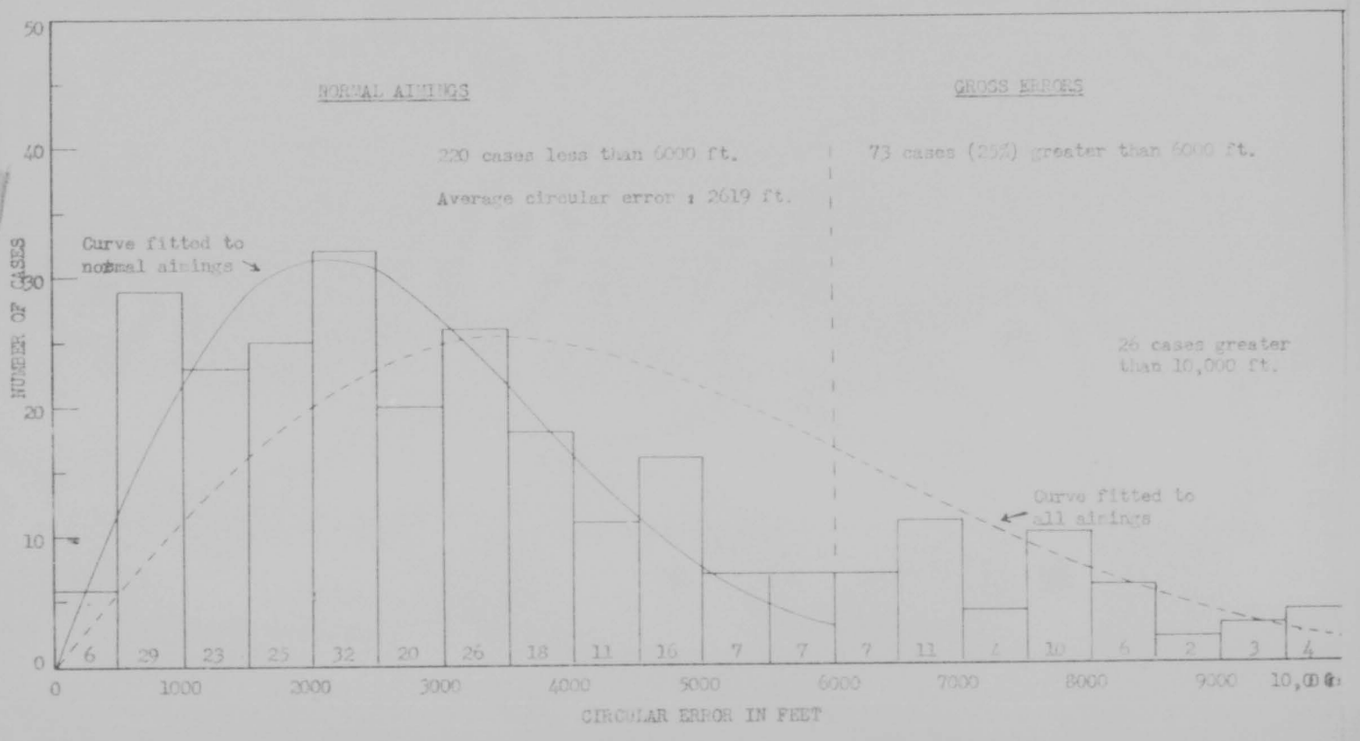


FIGURE 1.

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ENEMY REACTION ANALYSIS



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of The Commanding General Army Air Forces
12 Oct 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

12 October 1944

MEMORANDUM FOR THE CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: The Applicability of Enemy Reaction Analysis to Operations of Twentieth Air Force and Preliminary Requirements for Effective Employment of the Eighth Air Force System.

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I. Introduction

1. The Eighth Air Force has developed a technique, originating in the COPC and continued in Operations, by which enemy fighter reactions to our heavy bombardment operations can be anticipated and countered. From analysis of "time maps" reconstructing the enemy tactics on past missions, it has been possible to provide the Command with invaluable assistance in planning future operations. In particular, enemy reaction studies have been the basis of route planning and the allocation of fighter escort.

2. The purpose of the memorandum is to assess the applicability of this technique as an aid to the planning of operations by the Twentieth Air Force Commands. Accordingly, the following questions will be examined in turn:

a. Is the required intelligence available at present? If not, is there reasonable expectation that it will become available?

b. Are the tactical problems facing B-29 commanders similar to those facing the Eighth Air Force? Wherein are they different? Are the differences such that time maps and other planning aids connected with enemy reaction studies will not be needed, or can they be adapted to the tactical problems of the Twentieth Air Force?

c. In order to take full advantage of the potentialities of enemy reaction studies, what steps must be taken by the Twentieth Air Force to insure adequate intelligence? What personnel, training, and equipment will be required?

II. Comparison With Eighth Air Force Situation and Application of System to Twentieth Air Force

1. Over the course of 5 years of aerial warfare with Germany, a vast treasury of information and trained intelligence personnel has been accumulated regarding the German Air Force organization, tactics and capabilities. Eighth Air Force personnel responsible for making enemy reaction studies had



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direct access to all sources of this information.

a. In contemplating large scale air efforts against Japan and the role that can be played by enemy reaction analysis, it is immediately apparent that neither is there available intelligence of similar completeness and reliability concerning the Japanese Air Force, nor is command personnel going to have the facilities for quick and easy access to needed information which characterized the situation where an analyst of enemy reaction could walk across the room or telephone Air Ministry to fill in a gap in his knowledge.

b. It is important, therefore, not to expect too much of enemy reaction studies, especially at first. Until preparations can be made to collect the necessary intelligence, and to assure its continued flow, and until we have conducted a sufficient number of operations to be studied and a pattern of enemy reaction begins to emerge, operational planning, as regards outguessing, out maneuvering, or confusing fighters and avaiding tactical surprise, must be done somewhat in the dark.

c. On the other hand, experience in the Eighth Air Force has so demonstrated the value of enemy reaction analysis in operational planning that the employment of this technique even when based on the scantiest information can be expected to produce positive results. As time goes on constant improvement in knowledge of enemy interception tactics and in ability to develop sound operational plans should result.

2. As the Eighth Air Force developed more and more understanding of enemy fighter reaction, it became able to exploit that information in its operational planning. In particular enemy reaction analysis became the basis of: (a) route selection and timing to minimize (or to court) enemy fighter opposition, (b) the space-time deployment of fighter escort, and (c) plans to confuse or disrupt the enemy defenses by the use of diversions feints, spoofs and all kinds of secondary efforts.

a. The tactical problem facing the Eighth Air Force differs sharply from that of the Twentieth Air Force in several important respects; to each of which the operational planning for the Twentieth must be adjusted:

(1) The availability of fighter escort, distance from base to target.

(2) The margin of fuel supply.

(3) The depth of penetration and consequent duration of potential enemy fighter attacks.

(4) The concentration in time of the attacking bomber force.





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(5) The size and flexibility of the striking force.

b. In the early period of its operation, before long range fighters were available to the Eighth Air Force, route planning was designed to carry the undefended bomber force to the target and back in such a way as to minimize the chance of interception. Later when long range fighters were available, one of the chief uses of enemy reaction analysis was to anticipate the fighter opposition and to deploy our escort fighters in such a way as to offer the maximum defense against the greatest potential concentration of enemy aircraft. (see "fighter profiles") In the Twentieth Air Force, the elaborate technique of dispatching relays of fighters to offer protection throughout the route is neither necessary nor possible. Fighter protection for China based B-29's while crossing China on penetration and withdrawal can be developed and target support over the Japanese mainland may be a requisite as Japanese defense stiffens, as we get closer bases and/or the development of the P-47-N. At first however, the Twentieth Air Force, will be obliged to do its operational planning on the assumption that friendly fighters will be available only to protect our bases. This will be comparable to the early period of the Eighth Air Force, particularly in the case of the 20th Bomber Command.

c. With the development of wing tanks in heavy bombers, practically all of enemy controlled Europe was brought well within bomber range. Indeed there was sufficient margin of fuel supply to permit a considerable amount of route variation. In the immediate future the bases open to B-29's will be at such great distances from our targets, that increases in the amount of the fuel carried can be made only at the expense of the bomb load. This fuel-bomb load balance is so critical that it is unlikely that it will be considered desirable to take any but the most direct routes to and from the target. Unless offset by other measures to deceive the enemy as to our intentions, this will place our operational planning at a great disadvantage, since it will preclude flexibility of attack, eliminate tactical surprise and greatly simplify the enemy defensive tactics. Enemy reation analysis can play a great part in this connection.

d. In the Eighth Air Force, the tactical problem was complicated by the fact that many targets were deep into enemy territory and attacks had to be anticipated throughout a large part of penetration and withdrawal as well as at the target. Accordingly route planning and fighter escort deployment had to be calculated to exploit all weakness in the enemy system of mobilizing his forces based throughout the territory he controlled. China based operations may be somewhat analogous to the deep penetrations of Germany from the United Kingdom but Pacific based B-29 operations will be more similar to attacks on Wilhelmshaven, i.e., long overwater flights without opposition, and a quick strike over land with an overwater withdrawal. Since our attacks on the Japanese mainland will all be of this sort, with no aircraft required to be over land for more than about 20 minutes, we shall enjoy a tactical advantage which we should be prepared to exploit to the fullest, through knowledge of enemy interception tactics and capabilities.



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e. As the Eighth Air Force grew in size and experience it was customary to mass a large force for attacks and to keep them closely concentrated in time. With bombing done by units of 12-18, with combat wings of 3 such bombing units flying closely together under a single air commander and with minimum spacing between Combat Wings, a technique of attack was developed by which the entire striking force was fairly closely concentrated in time and space. The defensive advantages, both against flak and fighters and for the optimum use of fighter escort are obvious. Twentieth Air Force experience to date indicates that similar concentrations have not been achieved with B-29's. Even with forces of 100 aircraft or less, our attacks have been spread over a time period of one hour or more. Fuel conservation may preclude assembly, limited number of bases may aggravate the problem, and the distance from base to target may inevitably tend to string out the striking force. Unless methods can be developed to accomplish a higher degree of concentration, the Twentieth Air Force will tend to lose the great potential tactical advantage described in d. above. Instead, tactical surprise will be nullified and the enemy will have time to mobilize his fighter forces from a considerable distance, even without much advance warning, and many of his fighters will be able to fly second sorties.

f. By the time the operations of the Eighth Air Force became full scale, many advantages accrued which will not be immediately available to the Twentieth Air Force but which should be anticipated. For instance, sheer numbers of bombers permitted split attacks, availability of the 15th and 8th Air Force through USSTAF provided great possibilities for confusing and swamping enemy defenses. On a small scale, the Twentieth Bomber Command and the 14th Air Force might be able to accomplish something in this direction, but for the most part, such accomplishments lie in the future for the Twentieth Air Force.

3. In summary, when we consider the potentialities of the enemy reaction analysis technique for use in the Twentieth Air Force, we find that:

a. We must start out with far less intelligence than was available to the Eighth Air Force, and with a likelihood that it never will be equalled in completeness and accuracy and accessibility.

b. We shall face tactical problems which differ in many respects from those of the Eighth Air Force, so that the translation of enemy reaction data into operational plans cannot be borrowed in toto for use in the Twentieth Air Force.

(1) Nevertheless, it is obvious that the more we know about enemy capabilities and tactics, the better are we able to exploit that information to our tactical advantage.



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(2) As we commence our operations, the safest procedure will be to assume that the enemy is as capable as the German, and to borrow from our European experience in planning our operations. Meanwhile every effort should be made to accumulate as much information as possible, analyse it and bring to the attention of the operational planners. Then as time goes on, we can expect progressively valuable contributions to planning on the basis of studies of enemy reaction.

III. Requirements

In order to realize the full value of enemy reaction analyses, and to exploit the tactical situation thereby developed in the planning and execution of operations, Twentieth Air Force will require additional intelligence facilities, training, personnel and equipment.

1. Intelligence from Air Force to Commands: There are certain basic items of intelligence which must be furnished to commands from sources other than those which they themselves will develop through the system of enemy reaction analysis. These are listed below with comments on their present status and relative importance.

a. Air Order of Battle: This intelligence is most important for purposes of enemy reaction analysis and mission planning. It is developed and supplied by G-2, A G-2 Officer will be assigned to each command and will receive direct from G-2 in Washington all available intelligence on the subject. At the present time order of battle information with respect to the areas in which Twentieth Air Force Commands are and will be operating is extremely meagre, precise information as to unit locations being completely lacking. However, fairly reliable area estimates are currently available and these can be employed as a starting point. Anything that can be done to increase the amount and quality of order of battle information will operate to minimise the hazard of enemy fighter opposition and it is recommended that the entire situation should be carefully reviewed with G-2 with this end in view. The employment of R/T intercept receivers on current Twentieth Air Force operations may contribute considerable additional information.

b. Organization of Enemy Air Force: This intelligence, which includes such things as chain of command, designations of command and operating units, supply organizations, pilot training, areas of operation and jurisdiction, and personalities, is helpful to an understanding of enemy reaction and interception tactics. Such information is developed and supplied by G-2 in the same way as order of battle (a supra). It is at present not comparable either in scope or detail to that available with respect to the German Air Force.



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c. Enemy Warning System: This information ranks in importance with Enemy Air Order of Battle as a basis for enemy reaction analysis and mission planning. It is likewise developed by G-2 and made available to commands through the assigned G-2 officer. At the present time it appears to be even less abundant than air order of battle intelligence. The following items of information should be developed and furnished to commands with the aid of G-2, Signals, and the Operations Analysis Section:

(1) Location of enemy warning equipment.

(2) Capabilities and limitations of equipment.

(3) Observer Corps unit locations.

(4) Communications.

(5) Details of warning system.

(6) Susceptibility to radio counter-measures.

d. Enemy Fighter Control System: At the present time there appears to be no information available on enemy fighter control. Knowledge of enemy fighter control is absolutely essential to mission planning from the standpoint of enemy air opposition. Primarily this will have to be developed by means of R/T intercepter on current operations, but it is probable that information already developed by other air forces opposed by the Japanese will give some indication of what, if any, the system is. It is recommended that the experience and information of other air forces be examined and that such intelligence as may be thereby developed be evaluated and transmitted to commands.

e. Enemy Fighters: Information on the types and performance of enemy fighters in highly important Commands should be furnished all available data on such items as rates of climb, maximum and cruising speeds at various altitudes, fighting efficiency at various altitudes, endurance, armament, extra fuel tanks, etc. It is thought that the Navy is developing this information.

f. Miscellaneous Reports: Of substantial aid in enemy reaction analysis and mission planning are innumerable items of information derived from P/W reports, captured documents, and special reports on matters pertaining to the enemy fighter force. Currently G-2 is incorporating such items in the order of battle and other information transmitted direct to the G-2 officer at command. It is suggested that the information available in G-2 should be examined from the standpoint of enemy reaction analysis to ascertain whether all pertinent types of data are being included in the material transmitted.

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g. Enemy Reaction to other Twentieth Air Force Commands: As the various commands will be, in general, opposed by the same enemy fighter force, it is essential that the experience and information developed by any one command on a particular mission be made available as rapidly as possible to all other commands. In order that this material be comprehensible and designed for maximum utulity, it is suggested that a standard procedure for reporting on enemy fighter reaction be adopted at all of the commands.

2. Equipment Required by Commands: The following items of signals equipment will be required by the commands:

a. R/T intercept ("Y") receivers. These are of two types, namely, automatic recorders which monitor R/T traffic on a pre-set frequency, and selective receivers by means of which an airborne operator selects, monitors, and transcribes R/T traffic on various frequencies. The latter are obviously the more effective but their employment will involve the question of the availability of qualified linquists to act as operators and the attendant question, if such operators are Nisei, of their flying over enemy territory. These questions are again referred to in Par. 3, Personnel, but decisions on them are a prerequisite to determining which type of receiver will be employed.

b. Search receivers: As a preliminary to the employment of R/T intercept ("Y") receivers, as a means of developing intelligence on the enemy warning system, and as a condition precedent with respect to the use of RCM both against enemy warning equipment and against enemy fighter control, search receiving equipment must be supplied to the commands. This equipment must be of two types, namely, radar searching and R/T searching.

c. RCM: Following a determination of the needs of the commands, all of the necessary equipment for the effective use of radio countermeasures will have to be obtained and furnished to the commands. In general, this equipment will be of two types, namely R/T and radar jamming devices and equipment for spoofing.

3. Personnel Required by Commands:

a. In combat echelon:

(1) Airborne ("Y") operators. If it is determined that airborne Operators will be employed to operate R/T intercept receivers, Japanese speaking personnel will have to be furnished to the combat units for this purpose. If automatic recorders are employed communications may be such



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as to require the presence of qualified transcribers at combat units to transcribe the recorded traffic for transmission to Command Headquarters.

(2) Search Receiver Operators. Operators qualified to operate radar and R/T frequency search equipment will have to be furnished to combat units. Those searching in connection with R/T frequencies will have to be Japanese-speaking.

(3) Maintenance personnel. Personnel qualified to maintain both the search and intercept receivers will have to be furnished to the combat units.

(4) RCM Personnel. Personnel qualified in the maintenance and, in some instances, the operation of RCM equipment will have to be furnished to the combat units.

b. Personnel required in Command Headquarters: It is tentatively recommended that the following personnel will be required at each Command Headquarters to carry out the enemy reaction analysis and assistance in mission planning.

(1) Commissioned Officers:

(a) 3 analysts
(b) 1 navigator (part-time analyst)
(c) 1 R/T intercept ("Y") expert (part-time analyst) Japanese speaking
(d) 1 RCM expert

(2) Enlisted personnel:

(a) 1 administrative clerk
(b) 1 typist
(c) 3 draftsman
(d) 2 translators - Japanese-speaking.

4. Training of Personnel: It is suggested that the personnel needed of the commands in connection with enemy reaction analysis and mission planning can best be filled by the institution of a training program in the U.S.A. Training would fall into four personnel categories, as follows:



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a. Search Operators and Airborne "Y" Operators: The training of these operators would include the following items:

(1) Use of Equipment.

(2) Frequencies to be monitored.

(3) Detailed instruction on enemy fighter control organization, interception tactics, call signs, unit designations, and various types of R/T chatter.

b. Maintenance Personne: The training of maintenance personnel on search, airborne "Y", and RCM equipment should be the responsibility of Signals.

c. Intelligence Personnel for Command Headquarters: By selection and training before assignment commands can be furnished with intelligence personnel conversant with all phases of enemy fighter reaction analysis and its employment in mission planning. Most important of all is the training of Officers to fill the position of airborne "Y" expert in the analyses sections. They must be Japanese speaking and equipped with all available information on enemy fighter control, frequencies employed, call signs, unit designations, etc., which will result in comprehensive procurement and correct interpretation of R/T traffic.

d. Indoctrination of Operations Officers: It is suggested that one of the greatest aids to the effective employment of enemy reaction analysis in mission planning is an understanding on the part of all operations officers and controllers at the planning level of the purpose of such analyses and of the application of the information derived. Accordingly, some sort of indoctrination whereby they would acquire this understanding and also a general picture of the technique of enemy fighter opposition to our bomber operations is considered to be highly desirable.

5. Enemy Reaction Reports from Commands to Air Force: It is suggested that in order to make available to each command the information and experience of the others and also to assist Air Force in the planning of coordinated operations by two or more commands and in the carrying out of its training program, machinery should be set up for the receipt by Air Force from commands of the following reports:

a. Immediate mission reports, giving time, place, number and types of enemy fighters encountered, combat tactics, causes of loss, "Y" information bearing on enemy interception tactics, order of battle, and early warning, and RCM employed on the mission. The information contained in these reports to be evaluated and disseminated with the least possible delay to the other commands in order to avoid tactical surprise from the enemy and to exploit enemy weakness.



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b. Final detailed enemy reaction analyses of each mission flown whereby Air Forces can keep abreast of the enemy fighter opposition situation and be equipped to plan coordinated operations, when necessary.

c. Special reports on airborne R/T interception, giving frequencies, call signs, and such other similar information as will assist in the training program.

d. Special RCM reports for use in training, for Air Force coordination of employment of RCM by commands, and as a basis for the planning of coordinated operations.

IV Immediate Recommendations

1. In the United Kingdom, the entire matter of enemy R/T interception ("Y") was handled by the Air Ministry, and the Eighth Air Force personnel engaged in enemy reaction analysis acted solely as consumers of the intelligence developed from this source. To a certain extent, a similar situation may exist in the Pacific with the Navy and various other U. S. services developing a great deal of the required intelligence. On the other hand, Twentieth Air Force Command will be developing information through the operation of airborne ("Y") receivers. It is recommended that a survey be made of the entire ("Y") situation so that the problems of Twentieth Air Force can be adequately assessed and the necessary steps taken to see that both Commands and Air Force requirements are fulfilled.

2. The collection and dissemination of much of the Intelligence required for enemy reaction analyses, is the responsibility of G-2. In order that the needs of the Twentieth Air Force and its component commands be fully satisfied, it is imperative that the closest coordination between G-2 and Twentieth Air Force be achieved. To this end, it is recommended that a Twentieth Air Force Officer, thoroughly familiar with the technique of enemy reaction analysis, be assigned to liaison with G-2. This officer should become familiar in detail with all the sources of G-2 information, should be able to inform G-2 of the specific needs of the Twentieth Air Force, as to the substance and the form of required intelligence and should assist in the dissemination of that information within the Twentieth Air Force.

3. Similar liaison should be established with Signals and with OCR to monitor the acquisition of the necessary equipment for search receivers of radar and R/T, airborne ("Y") and RCM, and for the requisite training of operating and maintenance personnel.

4. In order that operations personnel can be indoctrinated in the uses of enemy reaction analysis and to provide for the training of analysts to perform the necessary work at Command level, it is recommended that AAFSAT

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be informed of this work and that the possibility be explored of their conducting the requisite training programs.

5. If it is determined that the enemy reaction system under discussion should be made available to all Twentieth Air Force Commands, it is recommended that on completion of all of the necessary preliminary work required here to make the system effective, and Officer of the Twentieth Air Force be sent out to the Twentieth Bomber Command to familiarize the Commanding General, Twentieth Bomber Command, with the technique and requirements involved and to assist in getting the project under way at that command. This has already been done at the Twenty-first Bomber Command and will ultimately have to be done at Twenty-second Bomber Command.

6. It is recommended that Major Denison Kitchel, who is familiar with enemy Reaction analysis be assigned to the staff of Twentieth Air Force to coordinate all of the requirements for its effective employment in commands. In this connection, Twentieth Air Force personnel should keep actively abreast of current enemy reaction and interception tactics as developed by the commands in order that such information and experience will be available to each command and at Headquarters Twentieth Air Force in the event coordinated operations by the commands becomes feasible as a means of minimizing enemy fighter opposition.

RICHARD G. GETTELL
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of
The Commanding General
Army Air Forces
18 Dec 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR SAVINGS BONDS AND STAMPS

18 December 1944

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Report on Conference with Reference to Setting Up Central Intelligence Organization in the Central Pacific.

1. On 14 December 1944, Colonel Turner, Deputy AC/AS, Intelligence, held a conference to discuss the desirability and possibility of setting up in the Central Pacific a central intelligence organization to perform for all air forces and commands engaged in the bombing offensive against the Japanese homeland the same functions as those currently performed in the B. T. O. by the Intelligence Section of the Combined Operational Planning Committee. The undersigned was requested to attend (a) as a representative of the Twentieth Air Force; and (b) as an ex-member of the Intelligence Section, C. O. P. C. Also requested to attend was Wing Commander Lee, R. A. F., who is the chief of the Enemy Air Order of Battle Section (A. I. 3 (b)) of Air Ministry, and is currently working with G-2 on Japanese Order of Battle. Lee had been a great enthusiast for our work in the U. K. and as the conference progressed it became apparent that it was he who had proposed a similar set-up in the Pacific. Other officers at the conference included representatives of various divisions of AAF Intelligence, of G-2, and of Signals.

2. Lee and the undersigned described to the conference the organization of the Intelligence Section, C. O. P. C., the intelligence system developed and employed by it, and the advantages derived from it by air forces engaged in the heavy bomber offensive against Germany.

3. Following discussion, it was agreed that the possibility of establishing such an organization and system in the Central Pacific Theatre should be explored and should be the subject of a staff memorandum from AC/AS, Intelligence, to the Commanding General, AAF. The undersigned was directed to prepare the material for Tab "A" of such a memo, outlining the organization, purpose, and functions of the Intelligence Section, C. O. P. C.

4. Attached is a copy of the draft memorandum prepared by the undersigned in compliance with that direction.

DENISON KITCHEL,
Major, Air Corps

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of The Commanding General Army Air Forces
19 Dec 44 RLS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

19 December 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Organization, Purpose and Functions of Intelligence Section, Combined Operational Planning Committee, European Theater of Operation.

I. Organization

1. The Intelligence Section was established as a part of the Combined Operational Planning Committee (C.O.P.C.) in June, 1943, and has functioned since that date under the direction of Major General O. A. Anderson. The personnel of the section is comprised of officers and enlisted men of the U.S.A.A.F. and the R.A.F.

II. Purpose

1. The primary purpose of the section is to assist in the planning of daylight heavy bomber operations from the U. K. with particular reference to the selection of routes, allocation of fighter escort, coordination of secondary efforts, holding attacks, diversions, and feints, and the employment of radio countermeasure and spoofs, all as related to enemy fighter reaction. A secondary purpose of the section is to act as a central agency for the reception, evaluation, employment and dissemination of all information and intelligence pertaining to enemy fighter reaction, fighter defenses and interception tactics.

III. Method

1. Mission Analysis - The section's method of forecasting enemy fighter reaction and wargaming proposed operations is predicated almost entirely on a system of analyzing the enemy fighter reaction to each mission flown. These analyses take the form of a series of time maps showing the relative positions of all aircraft, friendly and enemy, during the entire mission. On these maps by appropriate symbols and legends are depicted the routes flown, numbers and types of aircraft, both friendly and enemy, enemy order of battle, encounters and sighting, bomber losses and weather conditions, together with such printed matter as is necessary to complete the picture of the mission, such as comments on radio countermeasures employed, times of enemy early warning, pertinent intercepted R/T and W/T traffic not otherwise depicted, new tactics, new equipment, etc.

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2. Required Information and Intelligence - In order to make the analyses outlined in the preceding paragraph, certain information with respect to our own operations and intelligence on enemy activities are made available. These items are listed and briefly described as follows:

a. Information - Friendly

(1) Navigator's logs - accurate and detailed log of each independent bomber formation or unit.

(2) Fighter escort logs - accurate and detailed log of each independent fighter escort group or unit.

(3) Radio countermeasures - a complete report on all radio countermeasures, employed both on the ground and in the air in connection with the mission.

(4) Weather - reports on weather conditions encountered by bombers and fighters.

(5) Monitored friendly W/T and VHF traffic.

b. Intelligence

(1) Enemy Air Order of Battle - the best available information on the locations and numbers of enemy fighters within the area of possible interception either on direct sortie or by staging.

(2) Bomber crew observations - reports of all E/A sightings and encounters, giving time, coordinates, direction of flight, altitude, numbers, types, markings, descriptions of encounters, new armament, claims and losses (location).

(3) Fighter pilot observations - same as (2)

(4) Intercepted R/T and W/T traffic - covering all phases of mission, including early warning, fighter control, inter-squad, etc. from ground and airborne receivers.

(5) Weather - weather conditions at enemy fighter bases; this information is sometimes derived from intercepted R/T or W/T messages, otherwise it must be based on our own weather forecast.

3. Miscellaneous Intelligence - In addition to the information outlined in the preceding paragraph with respect to a specific mission, the section is supplied with an abundance of additional intelligence

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relating to the enemy fighter situation and capabilities. Some of these items are listed as follows:

a. P/W reports.

b. Captured documents.

c. Reports on captured enemy fighters.

d. Enemy airfield lists and airfield equipment

e. Reports on production, supply and wastage of enemy fighters.

f. Reports on enemy pilot training.

g. Reports on enemy early warning equipment and its capabilities.

h. Reports on enemy fighter radio equipment.

i. Technical reports on enemy fighter performance.

4. Specialist Personnel - Although all personnel in the section are, or rapidly become specialists in the field of enemy fighter reaction, personnel with particular specialties are included in the organization. These are enumerated as follows:

a. Personnel with high enemy language qualifications and with training and experience in monitoring enemy R/T and W/T traffic and in interpreting and evaluating intercepted messages.

b. Personnel trained and experienced in enemy order of battle intelligence.

c. Trained and operationally experienced navigators.

d. Personnel trained and experienced in radio equipment and radio countermeasures.

IV. Value and Employment of Mission Analyses

1. The primary value of the time map analyses lies in their contribution to the planning of future missions. This arises in several different ways:

a. The Commanding General and his staff can appreciate the important points with respect to enemy reaction to each mission in a minimum of time and with a maximum of clarity. Since the time maps are, in effect, a pictorial digest of everything known about the mission from the standpoint of enemy fighter reaction and interception tactics, the reading of a considerable volume of uncorrelated written material is eliminated.

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b. Review of past missions, or comparisons between two or more missions, can readily be effected.

c. Upon completion, each time map analysis of a mission affords a tremendous source for the derivation of information on enemy fighter performance and interception tactics. Examples of the statistics which can be developed are enumerated as follows:

(1) Early warning and alertness of fighter force.

(2) Maximum and average speeds of interception, and distances flown.

(3) Duration of combat and overall endurance.

(4) Length of time to refuel and re-arm for subsequent sorties.

(5) Enemy fighter control system.

(6) Percentages of enemy fighters reacting.

(7) Assembly points.

(8) Preferences in interception.

(9) Fighter units and bases employed.

(10) Capability of E/A to destroy our bombers.

d. Perhaps the most important advantage derived from time map analyses has been the development in the officers studying them continuously of a knowledge of the enemy fighter force and a "feel" of its reactions and interception tactics. This knowledge and "feel", together with the application of mathematical formulae derived from the studies, have produced a system and ability whereby enemy fighter reaction to proposed operations can be forecast with considerable accuracy and its effectiveness substantially countered.

e. The by-products of this system of enemy reaction analysis are numerous, chief among them being the correction of our own mistakes in the execution of missions and the development of information contributing directly to enemy order of battle intelligence.

f. Of the three major items of required intelligence, namely, Order of Battle, Crew Observations and Radio Intercepts, the first-named is probably the most basically important, but the three together are absolutely essential for complete reconstruction of enemy fighter

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reaction and interception tactics. Enemy Order of Battle intelligence in the ETO has been remarkably complete and accurate. Crew observations have developed in accuracy and completeness as a result of (1) a constant improvement in interrogation requirements and procedure, and (2) the gradual development in combat crews and fighter pilots of a real appreciation of the necessity for the information required and of its application in behalf of their safety and the success of subsequent operations. Radio Intercepts, with particular reference to the interception of enemy R/T traffic, have gone through a cycle of effectiveness in the ETO commensurate with the increase in depth of penetration by our bombers and fighters and the gradual movement eastward of the German fighter force. When penetrations of enemy territory were predominately shallow and the enemy fighters were deployed along the western perimeter of the European continent, ground listening stations in the U. K. afforded complete coverage. A hiatus in the availability of valuable R/T intercepts was experienced during a period of many months when operations were at extreme depth and beyond the range of ground listening stations. This was finally corrected and fairly complete coverage is now available as a result of the employment of airborne receivers and operators on each mission.

V. Examples of Tactical Benefits Derived in ETO

1. As a result of the system described in the foregoing paragraphs, many tactical benefits have been derived in the ETO. Some typical examples are enumerated, as follows:

a. Ability to select routes involving a minimum of enemy fighter interception or, as is often the case, provoking a major air battle as part of the counter-air offensive.

b. Ability to allocate fighter escort along the route selected so as to provide a maximum of defense in known areas of threat and a minimum of defense in known areas of meagre interception capabilities.

c. Ability to anticipate the points of enemy interception and the size of the intercepting force.

d. Ability to operate fighter sweeps ahead of the bombers in areas of enemy fighter air assembly and concentration.

e. When fighter escort unavailable or insufficient, ability to afford protection to an unescorted bomber force by means of radio countermeasures, diversions, secondary efforts or feints designed to disrupt enemy fighter control system and interception program.

f. Ability to discern the circumstances to which the enemy

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most frequently directs his interception and attack, i.e., situations deemed most desirable by the enemy for successful opposition such as straying formations, stragglers, loose formations, etc. This also involves an appreciation of the enemy's ability to recognize and take advantage of such circumstances almost as quickly as they develop.

DENISON KITCHEL
Major, Air Corps
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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SAVE

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
Re
1 Jan 45 RLS
Date Initials

DK/elw
1 January 1945

MEMORANDUM FOR THE CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: "Y" Service for Twentieth Air Force Operations.

I. Purposes of Memorandum

1. The purposes of this memorandum are:

a. To describe the need for "Y" service in connection with Twentieth Air Force operations;

b. To state the general requirements for effective "Y" service;

c. To outline the present situation with respect to personnel and equipment;

d. To recommend the taking of certain action.

II. Need for "Y" Service

1. Japanese fighter opposition to current Twentieth Air Force operations appears to be only in a formative stage. The present situation may be comparable to that in the E. T. O. during the first six months of our heavy bomber offensive against the Germans, when mere handfuls of enemy fighters were experimenting with interception and combat tactics against heavy bomber daylight operations. That period of experimentation was the basis for the development of a fighter production program and of a fighter control system which now enables the enemy to oppose a single heavy bomber operation from the United Kingdom with as many as 800 fighters. That such substantial numerical opposition is at the same time relatively ineffectual can be attributed in great measure to the fact that from the very outset of our operations in the U. K., every possible means were employed to know everything there was to be known about the enemy's fighter defenses, his system and method of control, and his interception tactics and capabilities. With this accumulated knowledge and experience it has been possible to plan each mission on the basis of fairly accurate estimates of the time, place, and scale of the enemy fighter opposition to be encountered.

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2. There is every indication that the Japanese are now experimenting just as the Germans did. Each mission flown by the Twentieth Air Force furnishes the enemy with an additional "test tube." Order of battle intelligence indicates a present capability for substantial numerical opposition both on the Japanese Islands and in East China. This capability has not as yet been exercised by the enemy. There is also evidence of a substantial increase in the enemy's production of fighters specially designed for the interception of bombers. In other words, we have intelligence available concerning the enemy's numerical capabilities and his over-all intentions, i. e., order of battle and rate of fighter production, but, as distinguished from the comparable period in our operations from the U. K., we are not at the present time keeping pace with developments in Japanese methods of fighter control and in their interception tactics. If this gap in our intelligence should continue, there is a definite probability that the enemy will ultimately launch a program of large-scale, coordinated fighter opposition to our operations with the element of surprise greatly on his side so far as time, place, and strength of interception are concerned.

3. A most prolific and reliable source of intelligence on enemy fighter control and interception tactics is "Y" service--the interception, translation, interpretation, and evaluation of enemy R/T and W/T operational traffic. "Y" service supplies the missing link between enemy order of battle intelligence and intelligence developed from crew observation. The three together permit the making of accurate time map analyses of enemy fighter reaction to each mission. From these analyses information essential to mission planning is derived, of which the following are examples:

a. Percentage of fighters reacting;

b. Early warning and time of scrambling;

c. Speeds and distances of interception;

d. Time required to deliver fire;

e. Over-all endurance;

f. Time consumed in rearming and refueling;

g. Capability of making second and additional sorties;

h. Methods of fighter control;

i. Effect of RCM and radio spoofs;

j. Areas of maximum and minimum interception capabilities;

k. Assembly points;





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1. Interception tactics;

m. Effect of dog-legs, turns, feints, diversions, and secondary efforts.

Without "Y" service or some adequate substitute, such as P/W interrogation and captured documents giving the details of each enemy defensive operation (these obviously will not be available), items of information such as those enumerated above are left almost entirely to conjecture. Without them our knowledge is limited to two things, namely, the approximate numbers and locations of enemy fighters on the ground and the approximate locations and strengths of attack. How the enemy effected interception, what fighters were employed, why certain points on our routes were selected for interception, how the precise areas and strengths of enemy fighter opposition could have been anticipated and its effectiveness minimized, are all questions which must remain inadequately answered until the gap in our intelligence is filled.

4. It has been said on occasion that enemy fighter opposition is something over which an unescorted bomber force can have no control except through the medium of defensive fire power and evasive action when combat has been joined. This may be true of numerically weak, uncoordinated, and, accordingly, relatively ineffectual fighter opposition. It has been proved to be untrue, however, in the case of fighter opposition sufficiently great to saturate defensive fire power and to inflict severe losses. Such effective opposition requires considerable planning, control, and coordination on the part of the enemy, and in the deployment of a large fighter force there is an enforced tendency towards pattern of performance. It is no mean task to assemble a concentration of several hundred fighters and to effect an interception so timed and positioned as to deliver a crippling blow. If the methods and tactics employed by the enemy in accomplishing that task are known in advance by the bomber force there are many ways in which they may be disrupted and the effectiveness of interception minimized. "Y" service is essential to the gaining of that knowledge and that ability.

III. Effective "Y" Service for Twentieth Air Force

1. In General - It is believed that effective employment of intelligence developed through "Y" service will be enhanced by having a maximum of self-sufficiency in that service within the immediate direction and control of the Twentieth Air Force commands. This is not intended to minimize the benefits to be derived from additional "Y" information obtained by other air forces and by the Navy, but only to emphasize the need for immediately available and adequate coverage within the commands themselves.

2. Interception of W/T Traffic - If experience in the E. T. O. is a reliable indication, W/T intercepts will not develop as much information on enemy fighter activity during an operation as will the monitoring of



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R/T traffic. They may, however, fill a lot of holes in the R/T information, particularly with reference to weather, preliminary moves, early warning, take-offs, and landings. As distinguished from R/T intercepts, the effectiveness of W/T interception will probably not be substantially impaired by the long range characteristic of Twentieth Air Force operations. Adequate coverage should be obtained from ground listening posts in the vicinities of command headquarters. In the case of the XX Bomber Command, this means in the vicinity of advance headquarters in China.

3. Interception of R/T Traffic - While being the greater source of information on enemy fighter activity during an operation, the interception of R/T traffic presents at the same time far greater difficulties in the way of personnel and equipment than does W/T interception. This situation arises because:

a. R/T interception involves the monitoring of Japanese speech and

b. There are definite limitations on the range of the equipment employed. The combination of these two factors makes the employment of airborne, Japanese-speaking operators a positive requirement for Twentieth Air Force operations. As discussed more fully in the next paragraph, airborne speech-recording devices cannot be considered as an adequate substitute--they will merely serve as a desirable adjunct to the employment of qualified airborne operators. As there may be some distinction between the needs of the two Twentieth Air Force commands, currently operating against the Japanese, the requirements of each are discussed separately:

(1) XX Bomber Command - With a considerable volume of enemy fighters based on the continent and capable of intercepting the overland flights of this command to and from targets in Manchuria, East China, and Kyushu, it is quite probable that ground R/T listening posts set up in forward positions in unoccupied China would develop valuable information on enemy fighter activity from this source. Accordingly, it can be said that a part of this command's requirements for effective "Y" service can be filled by ground personnel and equipment. To this extent they are comparable to the requirements of the Eighth Air Force in the U. K. when penetrations of enemy held territory were shallow and were opposed by German fighters based and operating within the range of ground listening devices. Beyond that range, however, effective "Y" service for XX Bomber Command requires the employment of airborne personnel and equipment.

(2) XXI Bomber Command - The present offensive against Japanese bases on islands relatively close to the bases of this command in the Marianas, will probably result in the elimination of any real requirements for ground

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R/T listening posts as a part of an effective "Y" service program for this command. It can be assumed that almost all enemy fighter activity in opposition to the operations of XXI Bomber Command will be beyond the range of ground stations and that, accordingly, the needs of the command can only be filled by the employment of airborne personnel and equipment.

4. Evaluation of the Airborne Recorder for R/T Interception:

a. No clear picture of the equipment and personnel requirements for effective "Y" service can be obtained without an appreciation of the type of intelligence to be developed through the interception of enemy R/T traffic and the limitations of the airborne recorder. The airborne recorder has been pictured by some as the complete answer to the problem. In the opinion of the undersigned, it is not, and at best will serve only as a useful adjunct to the operation of intercept receivers by qualified airborne personnel.

b. The principal value of intercepted R/T traffic lies in its usefulness in the reconstruction of the details of enemy fighter reaction as related in time and space to the activities of our bomber forces. Intercepted R/T traffic not so related can be instructive from the standpoint of being better than nothing, but it falls far short of the mark as constructive intelligence. Accordingly, each message intercepted, in order to be of full value, must be identified as to the time it was transmitted by the enemy and as to the position, altitude, and heading of the bomber formation when the message was transmitted. As presently designed, the airborne recorder cannot automatically produce and record this information. It will have to be delivered to the recording medium by voice at the time that the message is intercepted.

c. The airborne recorder is not a radio. It merely serves the same purpose as a stenographer--it takes down whatever is dictated to it. In the case of recording enemy R/T traffic, the "dictation" comes from a radio, an intercept receiving set. Such a set is, in turn, only selective when operated by an operator. Otherwise it will intercept only such traffic as is broadcast on the frequency for which it is set. During a mission the air is filled with enemy and friendly R/T broadcasts on innumerable frequencies. The selection of the frequencies and of the broadcasts relating to enemy fighter activities is a job requiring constant vigil, ability to understand Japanese, and ability to evaluate the relevance of intercepted traffic. The receiving set cannot perform the job automatically. All that the combined efforts of the receiving set and the airborne recorder can produce without the aid of a qualified operator is a record, unrelated in time and space to our activities, of the R/T traffic on a single pre-set frequency. In connection with the inability to select frequencies automatically, it must be anticipated that the enemy will be using many frequencies for air-to-air and ground-to-air fighter control and that the frequencies employed will be constantly changing.



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d. The foregoing considerations indicate a positive requirement for airborne operators qualified to monitor Japanese speech and to operate both the receiving sets and the airborne recorder. Effective airborne R/T interception can be accomplished by the operator and the receiving set alone--the airborne recorder will only serve to increase the volume of recorded intercepts.

IV. Present Situation with Respect to Personnel and Equipment

1. General - It is believed that the ground aspects of "Y" service for XX and XXI Bomber Commands can, in the main, be taken care of by existing facilities, personnel, and equipment of the AAF Signals Intelligence Service, through its AAF Radio Squadrons, Mobile, already assigned to the India-Burma, Chinese, and Central Pacific Theaters, respectively. Their employment to fill the needs of Twentieth Air Force commands in this connection may take considerable coordinating, but at least they were designed for this very purpose and are in the theaters. The organization, functions, and locations of these squadrons are described more fully in the next paragraph. The situations with respect to equipment and personnel for airborne interception of enemy R/T traffic and with respect to personnel in the A-2 sections of XX and XXI Bomber Commands for the evaluation and employment of "Y" service material for tactical and strategic purposes do not present such ready answers and will be discussed in greater detail.

2. AAF Radio Squadrons, Mobile

a. Organization - AAF Manual 100-1 describes the general organization of these squadrons as follows:

(1). "The Air Forces Radio Squadron, Mobile, is a flexible mobile organization...designed to provide all the radio intelligence facilities...to be used by the Air Force to which it is assigned..."

(2) "One Squadron normally will be assigned to each combat Air Force. All missions concerning the air operational activities of the Squadron in the fulfillment of its responsibilities will be assigned by the Air Force A-2."

(3) "Each Squadron is basically composed of 23 officers and 292 enlisted men..."

b. Functions - The general functions of the squadrons are described in AAF Manual 100-1 as follows:

(1) "9. Functions of the Squadron include the installation, operation, and maintenance of radio intercept and direction-finding stations, cryptanalysis, intelligence evaluation, and other associated and necessary activities, for the purpose of:

(a) Obtaining and evaluating radio intelligence information by intercepting enemy radio trans-



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missions and finding position of enemy radio transmissions and finding position of enemy radio stations, enemy aircraft, and enemy vessels basing or operating aircraft;

(b) Establishing and maintaining an analysis unit for the breaking and study of coded or ciphered intercepted traffic capable of being broken in the field;

(c) Promptly transmitting to the Air Force Headquarters all radio intelligence and information obtained, or to the individual or others to whom it has been directed to be sent..."

c. Personnel - The T/O for these squadrons provides for trained specialists essential to carrying out its functions. In manning the squadrons going to the Far East the voice interceptors procured, trained, and assigned were almost all Nisei.

d. Equipment - Each squadron is equipped with the necessary facilities for ground interception of W/T and R/T and for finding positions of enemy radio transmission (D/F).

e. Present Assignment and Location of Squadrons

(1) India-Burma Theater - One squadron is assigned to the Tenth Air Force. Its services are, therefore, potentially available in connection with offensive operations of XX Bomber Command from bases in India.

(2) Chinese Theater - One squadron is assigned to the Fourteenth Air Force. Its services are, therefore, potentially available in connection with offensive operations of XX Bomber Command from bases in China.

(3) Central Pacific Theater - One squadron is assigned to the Theater Commander and is based at Guam. Its services should be available to XXI Bomber Command for both offensive and defensive operations.

3. Equipment for Airborne R/T Interception

a. Intercept Receivers - The basic equipment for airborne interception of enemy R/T traffic is a radio receiving set. The type employed by both the Eighth and Fifteenth Air Forces for this purpose is the AN/ARR5 and it has obtained very satisfactory results, covering frequencies from 30 to 140 megacycles. Thirty-two (32) of these receivers have been allocated to XX Bomber Command and fifty-six (56) to the XXI Bomber Command. A telecon inquiry was made of XXI Bomber Command on 20 December 1944, to ascertain the number of intercept receivers, AN/ARR5 and AN/ARR7 (for use on lower frequencies), currently available for use on operations. No



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reply has been received as yet, but it is assumed that at least insofar as AN/ARR5 is concerned, XXI Bomber Command is adequately equipped. A similar inquiry has not as yet been sent to XX Bomber Command, but there again allocations would indicate an adequate supply. Accordingly, it appears that if airborne operators are available, both commands are equipped to commence immediately searching enemy fighter control frequencies and intercepting enemy R/T fighter traffic, at least within the frequency range of the AN/ARR5.

b. Recorders and Recorder-Producers (Playback)

(1) Disc Recorder - The first airborne recorder designed and built to AAF Specifications was a disc recorder, AN/ANQ-2, with a complimentary playback device, the AN/GNQ-2. The recording medium, i. e., the plastic disc, employed in this recorder was found to be unsatisfactory at temperatures below -40° and above -75° C., and it is not being generally used for high altitude work or in tropical climates. It developed a reputation of being unsatisfactory for high altitudes without relation to temperatures and this reputation is believed by the Air Communications Officer to be erroneous. In his opinion the minimum temperatures encountered inside B-29's on current operations should not affect the AN/ANQ-2. There is not sufficient data available on maximum temperatures to determine their effect. One of these recorders was delivered to XXI Bomber Command at Peterson Field for test. No reply has yet been received to a telecon inquiry on 20 December 1944 as to the results of the tests. There is reason to believe, however, that by virtue of the pressurized cabin, the disc recorder, AN/ANQ-2, should be just as satisfactory for B-29 operations as the magnetic wire recorder, AN/ANQ-1, discussed in the next paragraph. If this should prove to be correct, it is possible that the disc recorder could be made available in quantity far more rapidly than the newly-designed wire recorder which has not yet been manufactured or tested. Thirteen (13) disc recorders, AN/ANQ-2, and one (1) playback device, AN/GNQ-2, were allocated to XX Bomber Command on 26 September, but have not been shipped, in the absence of a shipping request.

(2) Magnetic Wire Recorder - Fifteen (15) of the new wire recorders, AN/GNQ-1, and fifteen (15) of the complimentary playback devices, AN/GNQ-1, designed to AAF Specifications, are now being built at the laboratory. These are expected to be completed in the very near future. Twelve (12) of each have been allocated too, and will be shipped immediately upon completion to XXI Bomber Command. The remaining three of each will

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be delivered to the AAF Board for test with an A-1-A priority. Requirements for Very Heavy Bombers have been established by OC&R as follows:

| Equipment | Combat | Reconnaissance |
|---|---|---|
| AN/ANQ-1 | 2 per squadron | 1 per aircraft |
| AN/GNQ-1 | 1 per group | 1 per squadron |

Production of four hundred (400) AN/ANQ-1 has been contracted for and will proceed, but no further allocations will be made until the results of AAF Board Tests are available. Even if the tests should prove satisfactory, it is doubtful that these recorders would be available in quantity before the late spring of 1945.

4. Personnel for Airborne R/T Interception:

a. General - The first problem concerning personnel for the operation of airborne intercept receivers and, when available, airborne recorders, in connection with R/T (voice) interception is that of linguistic qualifications. A determination of these qualifications bears directly on the second and more fundamental problem, namely, that of procuring qualified personnel for the job. The manual operation of the equipment presents no obstacle, but the language requirement (Japanese) involves a difficult one. There are no persons qualified in the Japanese language and trained as voice interceptors assigned to Twentieth Air Force units.

b. Language Qualifications - Obviously, the person most desirable for airborne voice interception is one fluent in the enemy language, particularly in modern enemy slang, learned in the enemy system and method of fighter control, including callsigns, code words, and frequencies employed, and skilled in the operation of the necessary airborne equipment. Obviously, again, personnel qualified to a far lesser degree than that will have to be acceptable to the Twentieth Air Force. Fluency in the language is the prime requirement and, in this respect, Nisei are probably by far the best qualified. Until adequate recording equipment becomes available in quantity it appears that, except in a few rare instances, Nisei will be the only ones who can fill the bill. Thereafter, with the combination of recorders and the knowledge and experience accumulated through intercepts by Nisei, operators with sufficient understanding of Japanese to be able merely to identify messages intercepted should be able to carry on the job. In other words, in the opinion of the undersigned, the language standard will be very high at the outset, but will decrease as recording equipment becomes available and knowledge of the enemy accumulates.

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c. Available Personnel

(1) According to advice obtained from the Chief, Communications Training Branch, AC/AS, Training, each of the three radio squadrons mobile, referred to in paragraph IV 2 e, above, contains a large group of trained voice interceptors. These men were trained in Japanese voice interception at Pinedale, California, under a curriculum which included the monitoring of recorded Japanese fighter R/T traffic obtained by intercepts during actual combat operations. This training qualifies them, at least insofar as voice interception is concerned, for airborne as well as ground interception duties. They are almost all Nisei. That they are immediately available for employment on Twentieth Air Force operations is indicated by the following two factors:

(a) Distances involved, particularly with reference to the squadron stationed on Guam, are such that their employment for R/T interception with ground equipment exclusively would give them little or nothing to do and Twentieth Air Force little or no results.

(b) Each squadron is reputed to be presently overmanned with voice interceptors, even if ground interception requirements were normal.

(2) There is a related problem with respect to the employment of these available trained voice interceptors for airborne work. The problem arises only by virtue of rumor in the absence of any official ruling on the matter. It is that of whether or not Nisei will be permitted to participate in air operations over Japanese territory and take the risk of falling into enemy hands. It is submitted that, although the fate of Nisei under such circumstances would probably be an unfortunate one, the information which they need possess in the performance of duties as airborne voice interceptors could be so limited as to make its value to the enemy relatively unimportant.

5. Personnel for A-2 Sections

a. In order to insure the fulfillment of the "Y" service requirements of Twentieth Air Force commands and to effect the greatest employment of "Y" information in enemy fighter reaction analysis and in planning the A-2 Section of each command should have at least one "Y" specialist. This specialist should be a signals intelligence service officer with as many as possible of the following qualifications:

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(1) Familiarity with the method and system of enemy fighter control, including callsigns, frequencies, code words, and equipment.

(2) Technical knowledge of radio, both Morse and voice, as a means of communications, its characteristics, capabilities, and limitations. Especially necessary would be a knowledge of the characteristics of radio frequencies.

(3) General knowledge of cryptography and cryptographic systems, and detailed knowledge of radio intelligence procedures to include cryptanalysis and traffic analysis.

(4) Detailed knowledge of the capabilities of the radio squadron, mobile.

(5) Knowledge of radio and radar countermeasures procedures.

In connection with his work within the A-2 Section of the Command and in the direction of the activities of the radio intelligence squadron, mobile, each such officer should have available all intelligence relating to the enemy air force, with particular reference to organization, order of battle, and fighter control.

b. The present T/O for command A-2 sections does not provide for such officers, nor is it believed that officers with the required qualifications are readily available within the Army Air Forces.

V. Conclusions

1. General - There is an urgent need for the establishment of effective "Y" service for current operations of Twentieth Air Force Commands.

2. Requirements for Effective "Y" Service - The following are the requirements, in order of priority, for the establishment of effective "Y" service:

a. Airborne Voice Interceptors - Qualified personnel are available in the already assigned radio intelligence squadrons, mobile. Their assignment for duty on combat missions is all that is required. It is believed that two operators per mission per command will fulfill present experimental and exploratory requirements.

b. Airborne Intercept Receiving Sets - Sufficient of these sets (AN/ARR5) are thought to be available at commands to permit the immediate commencement of an effective intercept program with airborne operators.

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c. A-2 Section Personnel - There are not presently provided for or available the required "Y" specialists in Command A-2 sections for the direction of radio intelligence squadron activities and for the effective employment of "Y" information at command level.

d. Airborne Intercept Recording Equipment - This equipment, when available, will not be a substitute for qualified airborne voice interceptors and intercept receiving sets, but is highly desirable for the extension of the airborne R/T interception program.

VI. Recommendations

In accordance with the foregoing comments and conclusions, the following recommendations are submitted:

1. That copies of this memorandum be forwarded to XX and XXI Bomber Commands for their information, consideration, aand comment.

2. That commands be directed to requisition sufficient airborne intercept receiving sets (AN/ARR5) to make up existing deficiencies.

3. That commands be directed to institute the necessary theater action for the immediate employment on current operations of voice interceptors available in assigned radio intelligence squadrons, mobile.

4. That commands be directed to institute "Y" service programs and to inform this headquarters of their unfulfilled needs in connection therewith.

5. That the necessary action be taken with AC/AS OC&R, AC/AS Intelligence, and AC/S, G-2, to provide for and procure "Y" specialists (Signals Intelligence Service officers) for A-2 sections of commands.

6. That tests be conducted at Eglin Field to determined the performance of the airborne disc recorder, AN/ANQ-2, under simulated operational conditions in B-29 aircraft.

7. That the necessary action be taken to expedite the production, testing, perfecting and supplying of the new airborne magnetic wire recorder, AN/ANQ-1, and recorder-producer (playback), AN/GNQ-1.

8. That a long-range program be instituted at this headquarters for the fullest possible development and exploitation of "Y" service in connection with Twentieth Air Force operations, including:

a. Liaison and coordination with AC/S, G-2.

b. Liaison and coordination with Navy Signals Intelligence.

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c. Procurement and training of personnel for sustained operations.

d. Development and procurement of equipment.

e. Making available to commands and this headquarters "Y" information obtained by service organizations other than Twentieth Air Force.

f. Arrangements for the rapid exchange of "Y" information between commands.

g. Evaluation and employment of "Y" information at this headquarters for the planning of coordinated operations by Twentieth Air Force commands.

9. That a "field" survey of the current situation in each command be undertaken by an officer from this headquarters at the earliest possible date.

10. That copies of this memorandum be referred to AC/AS Intelligence, AC/AS OC&R, and AC/S, G-2, for information and comment.

DENISON KITCHEL
Major, Air Corps
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief,
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By [illegible] The [illegible] General Army Air Forces

1 Jan 45 R.L.S.
Date Initials

SAVE WASTE PAPER TO HELP WIN THE WAR

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

1 January 1945

MEMORANDUM FOR CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: An Estimate of Future Japanese Fighter Tactics Against B-29 Airplanes

1. Expected Performance and Ceilings for Japanese Fighter Airplanes:

In view of the fact that the Japanese had accurate information in January 1944 concerning the bomb load, range, and speed of the B-29, and even knew approximately how many B-29's would be in combat by January 1945, it is not astonishing that they have made intensive efforts to develop high-performance, high-altitude fighters to oppose B-29 Operations. The special incentive of defense against the B-29 is coupled with a fundamental change in Japanese principles regarding fighter aircraft. From building light, low-speed, lightly-armed, scantily-armored, but highly maneuverable fighters (for example, Zeke 32, Zeke 52, Oscar 1, Oscar 2, Tojo 1, and Tojo 2), the Japanese have turned to the construction of moderately heavy, high-speed, heavily-armed, well-armored, but still fairly maneuverable fighter aircraft. The new fighters of this type on which performance data are available are:

| Navy | Army |
|---|---|
| Jack (S/E) | Frank (S/E) |
| George (S/E) | Rob (S/E) |
| Luke (S/E) | |
| Sam (S/E) | |
| Denko (S/E) | |
| Jimpū (S/E) | |
| Tenrai (T/E) | |

Of these types, Jack, Sam, George, and Frank, are in quantity production, and very likely operational, while Luke, Denko, Jimpu, Tenrai, and Rob, are, so far as is known, only in small-scale production.

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Taking Tojo 2 as an example of the best early type of Japanese fighter, it is interesting to compare performance, weight, armament, and armor of Tojo 2 and the new fighters coming into operational use (See Table 1).

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| | Gross Weight | Maximum Speed (MPH) | Service Ceiling | Engines (HP)/Alt | Armament | Protection |
|---|---|---|---|---|---|---|
| Tojo 2 | 6,100 lbs. | 376 at 17,200 ft. | 36,500 ft. | 1500/S.L. | 4x12.7mm or 2x12.7 & 2x7.7mm | Pilot armor & ineffective leak protection. |
| Jack II | 7,080 lbs. | 407 at 17,400 ft. | 39,600 ft. | 1875/S.L. | 4x20mm | Probably no armor or self-sealing tanks. |
| Sam II | 8,380 lbs. | 397 at 19,700 ft. | | 1700/19,700 | 2x1.3 mm & 2x20mm | ? |
| George | 8,250 lbs. | 407 at 19,600 ft. | | 1680/19,600 | 2,3, or 4x20 & 2x7.7mm | ? |
| Frank 1 | ? | 422 at 21,000 ft. | 39,000 ft. | 1970/S.L. | 4x20mm at least | Probable pilot Armor & leak protection |
| Luke II | ? | | ? | 1750/29,500 | 2x20 & 1x30mm | Probable pilot Armor & leak protection. |
| Denko | ? | 420/at 32,800 ft. | Over 41,000 ft. | 1750/29,500 | 2x30mm & 2x20mm & 2x7.7mm | ? |
| Jimpu | ? | 425 at 29,500 ft. | Over 40,000 ft. | 1750/29,500 | 4x20mm | ? |
| Tenrai | ? | 420 at 19,700 ft. | ? | 1700 each / 19,700 | 1x30mm & 4x20mm | ? |
| Rob 1 | ? | 450 (?) | ? | ? | ? | ? |

TABLE I



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It is believed that the new fighters listed above will have no trouble in flying attack courses against B-29 airplanes at any altitude where B-29's can operate.

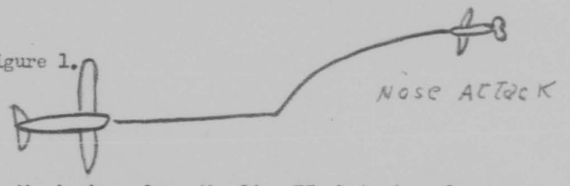
To recapitulate, it may be stated that the Japanese have in operation or will shortly have in operation very fast, heavily armed fighter aircraft having high service ceilings and ability to fly attack courses against B-29's at all altitudes. These fighters constitute an extremely serious threat to unescorted B-29 operations against Japan.

2. How Fighters Aim at Bombers.

In this section, we consider how fighters, once having got within range, execute their attacks.

The opinion has been widely held in the past that fighters can shoot successfully against bombers only if they fly pursuit courses. In executing a pursuit course attack, a fighter flies so that he keeps his nose always pointed slightly ahead of the bomber, putting in lead to allow for the forward motion of the bomber, as shown in Figure 1.

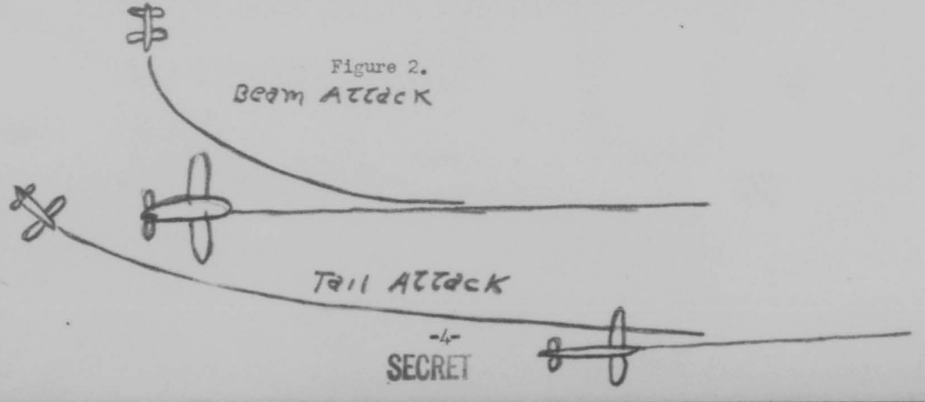
Figure 1.




The fighter sees the bomber along the line FT, but aims along the line FS at the point S; his lead is correct if the time taken by the bomber to travel the distance TS. During the time that the fighter aims in this way, he must fly on a curve which is determined by his range, altitude, speed, angle off, and the bomber's speed.

Typical pursuit courses starting at various angles off are shown in Figure 2.

Figure 2.



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It will be seen that for high speed bombers and fighters, the fighter will be drawn into very tight turns if he attacks at short ranges and near the beam.

A second way in which fighters may fire effectively at bombers is to fly a modified pursuit course, where they pull their point of aim through the bomber from front to back or back to front, hitting the bomber only for a second or two during a whole pass. This type of attack is easier to execute, particularly against a high speed bomber at high altitude, than a true pursuit course, and it is capable of delivering very effective fire. From study of P-47 attacks against B-29's at Almagordo, P-38 attacks against B-17's at Foster Field, and from conversations with fighter pilots, it has been concluded that this type of attack, which allows much wider turns during attacks and requires much less pilot skill, is very commonly used. This type of attack cannot be distinguished from a true pursuit course by looking at it, except in extreme cases.

Finally, a fighter may simply rake a whole formation without trying to hold a point of aim on any particular bomber. This "strafing" attack has been thought in the past to be ineffective, but this point of view is believed to be incorrect, especially against large formations, where the target is enormous. Strafing attacks have been reported against B-29 formations of XX Bomber Command.

It is believed that effective shooting by Japanese fighters against B-29 airplanes can be carried out by strafing attacks or modified pursuit courses from any direction, but that the most serious attacks are those within 30 degrees of nose and tail. In these areas, deflections are small, and little curvature of path is required for the fighter. These areas have been the dangerous ones for B-17 and B-24 operations in the ETO, and it seems reasonable to expect similar results with the Japanese.

The possibility of large-scale deliberate ramming attacks remains an open question. A small number of B-29 airplanes have been lost by ramming up to the present time, but no conclusive evidence exists that any ramming was deliberate. It is quite conceivable, however, that the Japanese may employ this technique when B-29 operations become sufficiently effective.

3. Present and Predicted Tactics.

Up to the present time, fighter opposition against operations of XX Bomber Command has been remarkably similar to fighter opposition against operations of VIII Bomber Command in the ETO. The Germans started out cautiously, experimenting with various forms of attack and not risking large number of fighters, against the small USAAF attacks (August 1942 - February 1943). This has been well paralleled by opposition to missions of XX Bomber Command, where opposition gradually grew in intensity, without exhibition of any brilliant techniques or massed attacks. This period (June 1944 to November 1944) was an experimental period, during which the

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Japanese were testing out the defensive capabilities of the B-29 along with their ability to attack it.

The German Air Force, when VIII Bomber Command Operations became effective, and when it had experimented long enough with attacking B-17's and B-24's, began making large scale attacks on our heavy bombers. These were characterized by fancy co-ordinated attacks, expert piloting, and serious but not prohibitive losses inflicted on the USAAF formations. During this period (March 1943 - August 1943), attacks from the sun, attacks using decoy aircraft, simultaneous attacks from several directions, and attacks from directly underneath, were often observed. German pilots displayed great virtuosity, performing slow rolls while making their passes and making breakaways through the formations. Missions 17- 19 of XX Bomber Command show the beginning of a similar phase in Japanese opposition to B-29 operations. The Japanese are beginning to make extensive use of co-ordinated attacks, attacks out of the sun, and breakaways through formations. The attacks themselves are like the German ones:

a. The queue-up, or chow-line attack, in which fighters line up alongside the formation to make their attacks;

b. Simultaneous passes from 5 and 7 o'clock or 10 and 11 o'clock;

c. The belly-button attack, consisting of a steep dive and zoom underneath the bomber, firing from directly below and hanging apparently motionless for a short space of time;

d. The use of decoy planes, which make feints and faked passes from 5, 6, or 7 o'clock, while two or more other fighters bore in from other points.

This curious identity in methods of attack makes it appear that the Japanese have had the opportunity of profiting from German experience.

A third stage in German opposition appeared in September 1943 - October 1943, when the German Air Force massed so much opposition against three or four Eighth Air Force operations that no deep penetrations were attempted thereafter until the introduction of full fighter escort.

The fourth and final stage in German opposition started in January 1944, when fighter escort was instituted for all deep penetrations. Under these circumstances, the Germans were forced to concentrate on formations which were temporarily without escort, whether through personnel error, engagement of all USAAF fighters, or insufficient fighter cover assigned. They have developed massed attacks by 10, 20, or 30 fighters at once, equally useful for nose and tail attacks, and they have learned how to knock down 10 to 15 bombers in the space of 2 or 3 minutes.

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It is the writer's opinion that stage 3 in Japanese opposition may be expected in the future, although no estimate can be made as to when Japanese air opposition will make losses prohibitive. The corresponding German experience, observed similarities between German and Japanese practices and techniques, and the current development of first class fighter aircraft by the Japanese make the development of large-scale and effective opposition a virtual certainty.

EDWIN HEWITT
OAD Consultant

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APPENDIX "A"

Actual Order of Attack of Different Aiming Points

| Order Over Target | Time | Wing | Group | M.P.I. |
|---|---|---|---|---|
| 1 | 2305 | 73 | 499:1 | 1 |
| 2 | 2306 | 73 | 499:2 | 1 |
| 3 | 2307 1/2 | 73 | 499:3 | 1 |
| 4 | 2308 | 73 | 499:4 | 1 |
| 5 | 2312 | 58 | 468:1 | 2 |
| 6 | 2314 | 58 | 468:2 | 2 |
| 7 | 2314 | 58 | 462:1 | 5 |
| 8 | 2316 | 313 | 6:1 | 3 |
| 9 | 2318 | 462 | 462:2 | 5 |
| 10 | 2320 | 313 | 505:1 | 1 |
| 11 | 2322 | 58 | 468:3 | 2 |
| 12 | 2324 | 313 | 505:2 | 1 |
| 13 | 2324 | 314 | 19:1 | 2 |
| 14 | 2324 1/2 | 314 | 19:2 | 2 |
| 15 | 2324 2/3 | 314 | 19:3 | 2 |
| 16 | 2326 | 314 | 19:4 | 2 |
| 17 | 2329 | 73 | 500:1 | 3 |
| 18 | 2329 | 73 | 500:2 | 3 |
| 19 | 2330 | 73 | 500:3 | 3 |
| 20 | 2333 | 58 | 40:1 | 4 |
| 21 | 2334 | 73 | 500:4 | 3 |
| 22 | 2334 | 58 | 444:1 | 3 |
| 23 | 2336 | 58 | 444:2 | 3 |
| 24 | 2336 | 314 | 39:1 | 3 |
| 25 | 2337 | 313 | 6:2 | 4 |
| 26 | 2337 1/2 | 314 | 39:2 | 3 |
| 27 | 2338 | 314 | 39:3 | 3 |
| 28 | 2338 | 314 | 39:4 | 3 |
| 29 | 2340 | 313 | 6:3 | 4 |
| 30 | 2341 | 58 | 444:3 | 3 |
| 31 | 2341 | 58 | 40:2 | 4 |
| 32 | 2342 | 313 | 505:3 | |
| 33 | 2345 1/2 | 58 | 462:3 | |
| 34 | 2351 1/2 | 314 | 29:1 | |
| 35 | 2352 | 314 | 29:2 | |
| 36 | 2352 | 314 | 29:3 | |
| 37 | 2353 | 314 | 29:4 | |
| 38 | 2354 | 73 | 498:1 | |

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Appendix "A" (Cont.)

| Order Over Target | Time | Wing | Group | M.P.I. |
|---|---|---|---|---|
| 39 | 2354 1/2 | 73 | 498:2 | 5 |
| 40 | 2355 | 73 | 498:3 | 5 |
| 41 | 2356 | 73 | 497:1 | 4 |
| 42 | 2357 | 73 | 497:2 | 4 |
| 43 | 2358 | 73 | 497:3 | 4 |
| 44 | 2358 | 73 | 497:4 | 4 |
| 45 | 2358 | 58 | 40:3 | 4 |
| 46 | 2359 | 58 | 462:4 | 5 |
| 47 | 0013 | 314 | 330:1 | 5 |
| 48 | 0014 | 314 | 330:2 | 5 |
| 49 | 0014 | 314 | 330:3 | 5 |
| 50 | 0015 | 314 | 330:4 | 5 |
| 51 | 0020 | 313 | 504:1 | 5 |
| 52 | 0025 | 313 | 504:2 | 5 |

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## APPENDIX "B"

### Method Used to Plot Bomb Impacts

All bomb impact points shown on the bomb plots 1 - 6 are computed from strike photographs showing bombs in air and sufficient ground detail to locate the course of the bombs relative to the ground.

The trajectory of any given bomb depends on the altitude, heading and true airspeed of the aircraft at bomb release, and on the wind velocity and direction. If these are accurately known then the trajectory can be obtained from the bombing tables and the impact point of the bomb can be computed. The limits of accuracy of this method would be of the order of 500 feet if sufficiently reliable information were available.

For conditions of altitude and ground speed as in Mission No. 174, every one degree error in drift contributesa deflection error of 200 feet and an error of one M.P.H. in ground speed produces a range error of 50 feet. This information as reported by the Groups through the Wings was in many cases internally contradictory and inconsistent in some casesdifferences appearing of up to twelve (12) degrees in drift and twenty (20) M.P.H. in ground speed appearing (to which would correspond errorsof 2,400 feet in deflection, and 1,000 feet in range respectively). The uniform procedure was adopted of using the reported T.A.S., heading, wind direction and velocity.

An additional error is introduced by the fact that according to the altitude and fuze settings reported, many of the E46 clusters opened at altitudes different from the briefed altitude of separation (5,000 feet). This error amounts to a range difference of ± 250 feet for the actual altitudes of separation in this mission.

In general, the computed impact point may be regarded as being within one half mile of the true impact point of that particular bomb. It is believed that any major inaccuracies are due to unreliable reported information.

Table I gives a measure of the bombing accuracy achieved by the various Wings during Mission No. 174. Many formations however, did not aim at their briefed A.P.'s when these were smoke covered and any conclusions regarding the bombing accuracy of this mission should recognize this fact.

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Table I

Bombing Accuracy by Wings

| Distance In Miles From Briefed A.P. | 58th B.W. | 73rd B.W. | 313th B.W. | 314th B.W. | Total |
|---|---|---|---|---|---|
| 0 to 1 | 6 - 50% | 1 - 9.1% | 1 - 14.3% | 2 - 17% | 10 - 24% |
| 1 to 2 | 4 - 33% | 7 - 64% | 4 - 57.1% | 3 - 25% | 18 - 43% |
| 2 to 3 | 2 - 17% | 1 - 9% | 1 - 14.3% | 4 - 33% | 8 - 19% |
| Beyond 3 | 0 - 0% | 2 - 18% | 1 - 14.3% | 3 - 25% | 6 - 14% |
| Total | 12 | 11 | 7 | 12 | 42 |
| Unaccounted For | 1 | 4 | 1 | 4 | 10 |
| | 13 | 15 | 8 | 16 | 52 |

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The plan to complete attacks on each M.P.I., in the order prescribed, appears to have been soundly conceived. It did not work perfectly in this attack because the earlier groups over the target did not succeed in concentrating their bombs on M.P.I.'s #1 and #2--partly because the order of attack was not adhered to but mainly because there were errors in aiming which put several of the early bombfalls near the later aiming points.

The strike photos furnish evidence that the surface wind, predicted to be from 260° at 8 knots, was probably blowing from the northwest during the attack. This is shown by a comparison of strike photos taken at different times, which indicates that the smoke near the ground tended to spread or drift towards the south or southeast.

The foregoing analysis may serve only to document matters already evident from the experience of this Command on the basis of this and other daylight incendiary attacks, namely--the rapidity with which smoke develops from fires set by preceding planes; the extent to which the smoke, once formed, billows out over a large area; and the difficulties encountered by the later formations because of the obscuration of the target by smoke.

On the other hand, it may serve to give emphasis to the following points:

(1) Where only one aiming point is involved, it may be expected that it, or the approach thereto, will be covered with smoke within a very few minutes after the first attack.

(2) Where, as in this attack, there are several carefully selected aiming points, there is still a substantial chance that most of the later formations will find their M.P.I.'s covered with smoke, or their vision thereto obscured. This will happen whenever:

(a) The precise order of attack is not carried out, and bombs are dropped on the later aiming points too soon; or

(b) Regardless of adherence to the time schedule, one or more of the earlier formations, attacking their assigned M.P.I.'s as planned, drop their bombs near other M.P.I.'s, or create smoke columns which obscure the other target areas.

It is unlikely that all the early formations will attack in precisely the order assigned or that they will put their bombs in exactly the places desired; hence it will be the exception rather than the rule that the approaches and sighting operations of the later formations will not be materially affected by smoke.





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(3) Because of the likelihood that, even in smaller attacks, the later formations will encounter difficulty with smoke, they should continue to be briefed, and trained to bomb by radar or through use of a reference point or offset A.P. This should not be regarded as an alternative to a normal visual sighting, but as the method that will probably have to be employed. A normal visual run should be considered as a possible alternative, rather than vice versa.

The extent of the possible smoke cover over the target area requires that the reference or offset points be selected as far as practicably possible away from the assigned M.P.I.'s lest such points, too, be smoke covered.

The aiming points for the later formations should be selected not only with regard to available offset points but, if at all possible, so as to be suitable for radar bombing.

(4) Since the fires set are not co-extensive with the area covered by the smoke therefrom, it is clear that dropping bombs into a smoke-covered area does not mean that it is being "over-bombed"; on the contrary it is important to attempt to drop on the assigned M.P.I.'s, so as to achieve the desired density of bombfall in that general area.

(5) Where, as in this attack, the time schedule has been worked out to minimize smoke obscuration of the later aiming points and effect concentration in time, of bombfalls around each M.P.I., particular stress should be laid on adherence to the specifiedtimes of attack. If, nevertheless, some formations arrive prematurely, consideration should be given to whether or not they should attack their assigned M.P.I., or bomb some other point. Possible alternatives are:

(a) To bomb the M.P.I. assigned,
(b) To bomb an M.P.I. corresponding with the time of attack, or
(c) To bomb some point beyond, and downwind of, the assigned M.P.I.

Each alternative has its disadvantages, which should be weighed in light of the general plan of attack and the particular target area.

IV. LOSS AND DAMAGE FROM FLAK AND FIGHTERS.

1. Enemy opposition on this mission was not very effective. Although 11 aircraft were lost, only 2 are charged to enemy action and only 1 to unknown cause; the remaining 8 were lost as a result of mechanical failure, accidents and bad weather at Iwo Jima. Thus, the rate of loss to enemy action is only 0.6% of airborne aircraft, even if



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the unknown loss is charged to enemy action.

2. The influence of time and altitude of bomb release is shown in Tables 6 and 7.

Table 6.

Influence of Time and Altitude of Release on Flak Damage*

| | 2305Z-2324Z | | 2325Z-2344Z | | 2345Z-0004Z | | 0005Z-0024Z | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A/C Relea. | A/C Hit | A/C Relea. | A/C Hit | A/C Relea. | A/C Hit | A/C Relea. | A/C Hit | A/C Relea. | A/C Hit |
| 19,000' and Up | 26 | 0 | 15 | 1 | 17 | 0 | 9 | 0 | 67 | 1 |
| 17,500 to 19,000 | 27 | 6 | 59 | 2 | 45 | 4 | 21 | 2 | 152 | 14 |
| 16,000 to 17,500 | 36 | 8 | 41 | 8 | 39 | 1 | 13 | 0 | 129 | 17 |
| Totals | 89 | 14 | 115 | 11 | 101 | 5 | 43 | 2 | 348 | 32 |

Two factors seem to bear strongly on flak damage:

(1) The earlier B-29's received most of the damage. In the first twenty minutes of the attack, 16% of our aircraft received flak hits. In the second twenty minutes, 10% were hit. Thereafter only 3% were hit. Inspection of the basic data shows a fairly sharp break in flak damage at the end of 30 minutes. This may be partially accounted for by the fact that by that time there was a heavy smoke spread over a large area of North Nagoya; however, heavy concentrations of smoke in various parts of the area had existed for some time prior thereto.

(2) The lower aircraft received more damage than higher ones. This tendency was not uniform, however. During the final 40 minutesof the attack, most of the damage was received by aircraft in the intermediate altitude range 17,500' - 18,999'.

*This table contains the 39 formations for which a satisfactory damage report is available.

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Table 7.

Fighter Attacks Sustained Between I.P. and Target And Between Target and Lands-End, According To Time and Altitude of Release.

| | 2305Z-2324Z | | | 2325Z-2344Z | | | 2345Z-0004Z | | | 0005Z-0024Z | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) |
| 19,000 and Up | 39 | 9 | 3 | 15 | 2 | 0 | 36 | 0 | 0 | 9 | 0 | 0 | 99 | 99 | 3 |
| 17,500 to 19,000 | 27 | 8 | 3 | 76 | 5 | 1 | 52 | 3 | 4 | 21 | 5 | 0 | 176 | 21 | 8 |
| 16,000 to 17,500 | 68 | 33 | 12 | 69 | 23 | 14 | 39 | 0 | 0 | 13 | 10 | 0 | 189 | 66 | 26 |
| Totals | 134 | 50 | 18 | 160 | 30 | 15 | 127 | 3 | 4 | 43 | 15 | 0 | 464 | 98 | 37 |

(1) A/C releasing; (2) Attacks from I.P. to target; (3) Target to Coast.

Fighter attacks also tended to be low and early. Notice that between target and coast no attacks were sustained by the last 43 aircraft; but that these aircraft received 15 attacks between I.P. and target where the preceding 127 aircraft had only 3 attacks. A possible explanation is that enemy fighters which followed the early B-29's past the target, came back in time to make a few passes at the tail end of our force over the target, and then broke off combat.

67% of the I.P. to target fighter attacks were received by the 41% of the aircraft which released below 17,500'. These 66 attacks are broken down as follows according to elevation and clock direction of the attack. The attacks tended to come from above, in spite of the fact that these were the low formations. 27% of all attacks came from high nose.

Table 8.

Fighter Attacks Received Between I.P. And Target by Formations Releasing Below 17,500 Ft.

| Elevation | Nose | Right | Left | Tail | Total |
|---|---|---|---|---|---|
| High | 18 | 4 | 3 | 5 | 30 |
| Level | 8 | 3 | 9 | 3 | 23 |
| Low | 6 | 2 | 4 | 1 | 13 |
| Total | 32 | 9 | 16 | 9 | 66 |





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Report prepared by:

NORMAN M. NEWMARK,
Deputy Chief,
Operations Analysis Section.

On the basis of data, on specific phases of the mission, furnished by the following Analysts:

ERICH L. LEHMANN,
(Bombing Accuracy).

GEORGE E. NICHOLSON, JR.,
(Bombing Accuracy).

J. VIRGIL PROCTOR,
(Planning).

JOSEPH L. HODGES, JR.,
(Battle Damage).

APPROVED:

LEROY A. BROTHERS,
Chief,
Operations Analysis Section.

Per: N.M.N.,
Acting Chief.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

26 October 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: The Possibility of a Gunsight "Filter" Employing Interrupted Light

1. In a memorandum prepared while at Hq. Second Air Force (attached), I described in a brief way the experimental and theoretical bases for the suggestion that certain inherent difficulties involved in the use of tinted glass filters in gunsights can be avoided by application of other means for the reduction of luminous flux. Reduction of brightness is required for scanning toward the sun. Situations do arise (enemy fighter coming in "out of the sun") in which it would be very desirable to be able to scan directly into the sun, which is now not possible if it is required to retain a reasonable degree of visual resolution. The difficulty with glass filters is that, for observation directly toward the sun, the filter must be so dense that the brightness level is reduced to a point at which effective acuity is not possible. Similar difficulties arise in the use of filters in visual range finders, and a similar solution is possible for such instruments as well as for a number of others. In addition to the direct visual limitation imposed by the reduction of brightness and loss of visual resolution, filters do not in general give guarrantee of safety from retinal burns, since they are likely to be too transparent in spectral regions outside the visual range.

2. Another method of reducing visual brightness is to view the field through a rotating sector disc. It is generally understood that with such a disc, rotating at a speed high enough to give subjective fusion of the effects of successive flashes, the apparent brightness of the subjectively continuous illumination is directly proportional to the fraction of the cycle time occupied by light. This I have recently verified quite exactly over a very wide range of light-time fractions (3 percent to 97 percent). What seems not to be generally known is the fact that over a considerable range of light-time fractions visual acuity, for certain types of patterns at least, is not a function of the subjective brightness when periodically interrupted light is used, but is instead dependent on the intensity of the single, repeated flash. For the visual resolution of a dot on a luminous field, cross hairs, lined patterns, and the like, it has been extensively verified under a variety of conditions of photic adaptation that down to 10 percent light-time the flash intensity is the same as that for simple continuous light. This means that, by use of, say, a sector wheel with 36 degrees total

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total opening, the subjective brightness may be reduced to one tenth of its value with continuous light, without (for simple patterns) much reducing the fineness of visual resolution. For scanning directly into the sun the brightness of the sun's disc must be reduced to about 5 percent of its native value before glare and brightness are lowered to the bearable level, and thus it is desirable to use in conjunction with the sector wheel a filter of, say 50 percent transmission, or even higher. Light-time fractions down to 3 percent are easily used with the sector disc.

3. A small adjustable-opening slotted sector wheel was constructed with a simple mounting permitting its attachment to a K-3 sight, in front of the combining glass frame. It was turned by a small motor (24v.) having a rheostat for adjustment of speed. For the purpose of rough tests (all that were contemplated at the time) no runs were made in actual flight. Qualitatively, the expectation of visual ease in looking toward the midday sun was abundantly verified, and also the ease with which a plane could be "picked up". The darkest filter available was needed to permit looking toward the sun and then visual discrimination was very poor indeed. The sight was examined by several men versed in gunnery and others, who found it easy to use. There is, of course, a certain disadvantage in the presence of a 10" rotating disc on the sight, as making for clumsiness and some possible mechanical interference, but this should not be severe. The driving motor, rheostat and the flexible driving shaft could be adjusted so as not to interfere with the operation of the sight. The sector wheel could obviously be adapted to free gun sighting, and even to goggles.

4. There are certain other aspects of vision with periodically interrupted light which require only brief mention here. When mountainous terrain is viewed in certain lights the resolution of detail is difficult. The sharpening of contrast along the contours of overlapping ranges is striking when such a scene is viewed with interrupted light. When the flash-frequency is reduced below the level of flicker fusion this sharpening of contours can be made use of. The experimental and theoretical basis for this development has already been published, and will be dealt with in a succeeding memorandum.

5. It is suggested that a manufacturer of sights could be approached with the view to incorporation of a flickering device in sighting heads. This could be perhaps done by a type of construction which would avoid the sector wheel, and be more compact. It would be desirable to combine any such project, I believe, with one concerning the possible application of interrupted dight to the improvement of the visual field in bomb sights (referred to in an accompanying memorandum).

W. J. CROZIER
Operations Analyst

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TWENTIETH AIR FORCE

OPERATIONS ANALYSIS SECTION

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MEMORANDUM

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SUBJECT: The possibility of a gunsight "filter" employing interrupted light.

DATE: 26 October 1944

AUTHOR: W. J. Crozier, Operations Analyst

DISTRIBUTION: Chief of Staff, Twentieth Air Force.

APPROVED

ROBERT L. STEARNS, Chief,
Operations Analysis Section
Twentieth Air Force

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HEADQUARTERS SECOND AIR FORCE
Operations Analysis Section
Colorado Springs, Colorado

11 July 1944.

ON VISUAL RESOLUTION WITH INTERRUPTED LIGHT, -- WITH PARTICULAR REFERENCE TO GUN -- SIGHTING PROBLEMS.

1. The ordinary theory of the visual resolution of the fine detail of seen patterns is in terms of the relation between resolving capacity and brightness. Up to a certain high level of luminous intensity the resolving capacity increases with increase of brightness. This has been explained on the basis that the level of luminous intensity determines the number of retinal receptor cells which can be concerned in effecting the spatial discrimination of intensity differences (brightness differences) in the seen pattern; there are a number of reasons why this theory cannot be correct. Above the brightness at which maximum visual resolution (for a pattern of a given type) is possible, glare, dazzle and effects similar to the solorization of a photographic plate are found to enter, so that resolving capacity becomes less. Discussion of these matters is commonly in terms of luminous intensity, without careful consideration of the complex interrelations between energy flux, intensity of light, and brightness. This has been largely because quantitative visual acuity has usually been studied, heretofore, under comparatively simple experimental conditions of exposure to continuous illumination of a test-pattern. Effects of special interest arise when the light used to illuminate the pattern, or by which the pattern is seen, is not continuous but is instead "chopped" by a sector wheel.

2. By suitable instrumental arrangements the cycle of alternating light and darkness produced by a sector wheel can be adjusted to contain a specified proportion of light-time in the flash-cycle, so that the light pulses are separated by known relative intervals of darkness. When this is done systematically, the brightness of the subjectively continuous, fused, light produced by flash frequencies above the frequency critical for fusion is rigorously proportional to the average light-flux. This fact, known as Talbot's Law, I have recently verified, for "white" light and for several spectral regions, over a wide range of light-time fractions (3 per centum to 95 per centum). The question then arises, does visual resolution in flickered light, as a function of subjective brightness, behave as it does with light not periodically interrupted? The answer is that it does not. In general, resolution is much higher than with continuous light of the same brightness. We are really concerned here only with certain practical applications, and no discussion of the theoretical significance or the physiological interpretation of this fact need be given here.

3. In several recent papers (cf. Jour. Gen. Physiology, vol. 27, pp. 401-432, 1944, etc; and a recent memorandum) I have shown that for a

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variety of simple patterns the lowest intensity for visual resolution is determined by the intensity of the single flash, not by the subjective brightness of the sectored light, down to a fairly low light-time fraction. These patterns included: The outline of an illuminated square; bars on a lighted area; cross hairs, seen foveally or in the dark adapted periphery. For certain pertinent patterns, subjectively fused sectored light with 20 per centum, or even 10 per centum, light-time fraction gives threshold resolution at the same single flash-intensity as for continuous light, although only one-fifth or one-tenth as bright. There is a lower limit of usefulness to the reduction of the light-time fraction, since at 5 per centum, and more evidently at 3 per centum light-time, the subjective brightness must be increased -- by increasing the flash-intensity -- until the brightness of the sectored light approximates that of the uninterrupted beam required for the particular threshold resolution. The lower limit of useful reduction of light-time fraction is a function of the relation of light-areas to dark areas in the pattern; it is lowest for simple patterns, such as cross hairs, or a plane in the sky.

4. Since over usable ranges of intensity visual acuity increases with intensity, the flicker effect on visual resolution really means that, starting with a natural source such as the sun, the brightness can be reduced by a suitable sector wheel to a level at which steady regard is possible, and at which visual resolution is superior to that permitted by the same brightness of non-interrupted light. The best effect, with the sun, is obtained by a combination of filter and sector wheel. One thus avoids the loss of flicker efficiency which would be entailed by the use of, say, a 3 per centum light-time sector wheel to obtain the required reduction in brightness. The enlargement of the pupil opening which accompanies the brightness reduction is an added advantage. The flicker effect also makes possible the availability of a wider range of light intensities for visual use than when filters are employed.

5. If the flash-frequency is systematically changed, from say, one per second up to the frequency, perhaps 15 per second, at which fusion is experienced and the individual flashes are no longer to be distinguished, it is found that at a flash-frequency between two per second and 10 per second, -- depending on the intensity of the light-beam, upon the light-time fraction, the area of the image, and certain other factors, -- the brightness of a single discrete flash passes through a maximum. At this maximum flash-brightness, the flash intensity critical for resolution of a simple pattern is the same as when the flash-frequency is increased to a little above the critical fusion frequency. The increase in brightness of single flashes in a train (Brucke effect) has been studied by Bartley and others, including myself; it is found that, for appropriate frequencies, the brightness may be as much as twice that of continuous light of the same intensity. The brightness of the dark interval changes similarly. Thus the brightness may be varied over a range of from one to four units without changing the flash intensity required for resolution of a given pattern.



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6. For reasons referred to in a previous note the convention has been adopted of estimating visual acuity by determining the relative light energy required to just permit resolution of a pattern, under different conditions. This is done in order to avoid the indefiniteness implicit in the traditional procedure whereby the smallest size of resolved image is measured as a function of critical intensity. The size of image, in a given series of tests, really has to be kept constant, as is easily shown; as well as the level of photic adaptation, and consequently the light intensity used, if theoretically useful results of minimum ambiguity are to be obtained. When single brief flashes of light are used, the intensity (not the brightness) required for resolution of a given pattern is a systematic function of the exposure time (i.e., of the duration of the flash) whether delivered to a dark adapted eye or to one adapted to a given level of brightness. This intensity is very much higher than when a train of successive flashes is used (i.e., flickered light). The "summative" effect here manifest has been examined extensively and an account of the work will be presented elsewhere.

7. It is readily appreciated that a difficulty in scanning near to, or into, the sun's disc, is the glare and dazzle encountered. This is at present counteracted, partly, by the use of neutral or other filters. The fact is, however, that unless the sun's brightness is reduced to something like 5 per centum or less, of its natural value continuous regard is impossible. When it is reduced to this extent by filters visual acuity, even with the eye adapted by sufficiently long viewing of this reduced brightness, is definitely too low. Ordinarily, the eye at a gunsight, for example, will be adapted to the higher brightnesses of the day, which makes the situation even worse. A further difficulty, which can be serious, is that unless filters are carefully selected they may transmit a large fraction of the infra red in the sun's radiation, -- actually enough of it to burn the retina although the field looks dim. The so-called "central fusion density" sun-scanning goggles which have been suggested suffer from this defect, as well as a number of others, and are not adapted to gun sighting anyway. The principle of the sector wheel, however, permits reduction of brightness and also reduction of energy flux (including the infra red). In general, for purposes of, say, a K-3 gun sight, a sector wheel with 20 per centum total opening, driven at 10 to 20 flashes per second, will reduce brightness and mean energy flux to 20 per centum; backed up by a "1/5" glass filter, the full intensity of the sun will be reduced to 4 per centum, yet the capacity for visual resolution will not be lowered below a useful level. A sector wheel with 10 per centum total sector opening, backed up by a "$\frac{1}{5}$" filter might be more useful. It is proposed that a variable - opening sector wheel be installed in a K-3 or K-4 sight to demonstrate the practicability of this procedure. It is to be added that protection of the visual system from the effects of gun flash dazzle, flares, and even of search lights can be developed in this manner. The "half black" goggles that have been suggested for the latter purpose (and are used somewhat by the Germans) are really of very small merit.



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8. This principle is applicable in filtered lights of different colors. The literature of "visual acuity" as a function of wave-length composition (color) is quite confused. Some aspects of this problem will be considered in a subsequent memorandum, at least for flickered simple fields containing light of only one color, the color threshold is primarily a matter of the subjective brightness, not of the physical intensity of a single flash.

9. This principle is obviously applicable to certain types of telescopes and other sighting devices. Certain of these applications involve additional properties of flickered light, which will be described in an additional memorandum. The possibility exists that by proper choice of a blue filter with a suitable lens the usefulness of certain optical instruments can be improved. At present it is desired to test particularly the performance of the flicker device with retiflector sights. A definite improvement in performance should result, not only for the reasons already indicated, but also because the illumination on the reticule can be less bright. It is proposed to institute in this connection measurements of the limiting visual acuity obtained with various sights, under actual working conditions. (Some strange notions about this seem to be prevalent just now, and some definite information is really needed; cf. a recent memorandum with Dr. Duren). The point should be made, finally, that with interrupted light visual resolution is dependent upon partial pressure of oxygen in inspired air in just the same way as with steady light. A succeeding memorandum deals with the oxygen effect.

DR. WM. J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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30 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Visit to Wright Field re: Sun Scanning

1. In connection with a suggestion earlier made for a "flicker" device to be used in scanning (particularly near and into the sun), a request for further information was received from Headquarters, ATSC at Wright Field (see copy of letter attached). On 21 December, I saw Lt. Colonel M. E. Gall at Armament Laboratory, Wright Field, and discussed the problem with him; and at greater length with Major C. J. McBride, with whom the inquiry had originated, and with Mr. Garde. The nature of the problem was gone into, and the pertinent visual physiology was briefly described. A sketch for an adjustable-opening sector wheel was provided. It is my understanding that one was to be constructed at once.

2. The Aero-Medical Laboratory, Engineering Division, Materiel Command, Wright Field, has responsibility for research, design and development of all types of goggles for AAF personnel (Major E. A. Pinson). It has been recognized that with goggles thus far tested there is the danger of possible injury to the retina by infra-red radiation, when scanning into the sun. A Variable Density Goggle (Polaroid discs) has been devised, but its transmission in the infra-red is high; if fogging can be prevented, it is said to be visually comfortable, however. With this goggle, however, as with the Newer Graded Density Goggle ("Sun Glass"), or with an additional dense lens, visual acuity is greatly diminished. With the flicker device referred to in (1) this is not the case. Some time was spent with Lt. Chapavis in the discussion of these matters, and in examining various types of goggle lenses and their properties.

3. Inquiry had been made (by Colonel Combs) as to the nature of "Steel Glass". The Special Equipment Section of the Armament Laboratory had not heard of it. The Aero Medical Laboratory had not heard of it, but it was presumed that it might be a trade name for one of the new types of laminated glass, which do not fracture readily as a result of impacts. I was not able to confirm this on inquiry of glass technologists at American Optical Company, but the same suggestion was expressed. I was able to see results of tests with

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fragmentation missals on goggles made of this laminated glass; the use of this glass is still being developed.

4. It is felt that too little is known here about goggle equipment and the like as use by enemy and allied air forces. Opportunity should be taken to obtain such equipment for study.

W. J. CROZIER
Operations Analyst

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IN REPLY ADDRESS BOTH COMMUNICATION AND ENVELOPE TO ATTENTION OF FOLLOWING OFFICE SYMBOL:
TSEMG (TSEPL-2C)

HEADQUARTERS, AIR TECHNICAL SERVICE COMMAND
Maj.C.J.McBride:nh
Ext. 2-8235

22 Nov 1944

Aircraft Scanner.

Commanding General,
Army Air Forces,
Washington 25, D. C.

Attn: AC/AS, Materiel and Services.

1. Information has been received by the Air Technical Service Command that a disc type scanner has been developed by your office. The purpose of this scanner was to make possible to a gunner the scanning of areas close to the direction of the sun.

2. It is believed that this device might be profitably employed by the Air Technical Service Command and any information concerning its design or a sample scanning device is requested. If a physical item is available, it is requested that it be sent to the Air Technical Service Command in accordance with the above reply reference to the attention of Lt. Colonel M. E. Gold.

3. It is requested that this information be transmitted to the Operations Analysis Section, Attn: Dr. William J. Crozier.

For the Director:

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

14 December 1944

A NOTE FOR THE INFORMATION OF:
LT. COLONEL J. R. DuBOSE, TWENTIETH AIR FORCE

Subject: Attached Report

1. As requested, I have read the Report "Crew Coordination in the B-29", dated 15 November 1944, and prepared by Operations Analysis Division, Headquarters, Second Air Force. The recommendations embodied in this Report appear highly satisfactory for training purposes with two exceptions which are discussed below.

2. The suggested possibilities for turret control (inclosure 1 to Report) appear to exhaust all practical possibilities and the identifying names are descriptive and easy to remember.

3. The SOP for target reporting (inclosure 2 to Report) is satisfactory, but will probably not be followed in combat, owing to ten shot duration of fighter attacks and the confusion almost always attendant upon fighter-bomber encounters.

4. I do not believe that evasive action should be initiated only by formation leaders (see inclosure 3, paragraph 2, b and c); on the basis of ETO experience, I would recommend vertical evasive action by any airplane in a formation when this airplane's situation demands it, except between IP and target. The recommendation for evasive action control by top or tail gunner is very good. I do not believe that the best maneuver against nose attacks is turning into the attack, (inclosure 3, paragraph 3-b (1), as this only gives the fighter a no-deflection shot. Turning away from a nose attack increases deflection for the fighter and tightens his turn. (If figures on the deflection and turn are desired, I will be glad to supply them). Also, I cannot concur in the recommendation (inclosure 3, paragraph 3-b (11)), that one should turn away from tail attacks. This may uncover the tail guns, but it decreases the fighters deflection and increases his radius of turn. This open question should be investigated further, as should the whole question of optimum evasive action.

5. The recommended SOP for turret allocation and transfer in various sizes of formation is highly desirable for training purposes. A crew well instructed in these procedures will be better capable of defending itself than those not so instructed. I do not believe, however, that these allocations of turret control are intended to cover all

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possible situations; special forms of attack encountered on operational missions may easily require a different type of defense (this is clearly stated in inclosure 1). I therefore recommend that the SOP set forth in inclosure 4 be concurred in for the use of the Second Air Force but that it not be incorporated in any tactical doctrine governing operations of the Twentieth Air Force.

EDWIN HEWITT
Operations Analyst

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The Commanding General
Army Air Forces
23 Dec. 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

23 December 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: "Tests Relative to the Defense and Tactical Use of the B-29" (By Department of Physics, University of New Mexico).

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I. Summary and Conclusions

1. A careful study was made by the undersigned of the method used by the UNM project in evaluating the defensive power of the B-29 airplane. This method has been found valid in most essential respects, and is considered to give an accurate analysis of what can be expected from B-29 defensive gunnery.

2. The alleged discrepancy between combat claims from XX Bomber Command for enemy aircraft destroyed, probably destroyed, and damaged, and the results obtained by the UNM group has been subjected to statistical analysis. From this it appears that the combat claims, so far as can be determined from information in Tactical Mission Reports, are generally in good agreement with the prediction of average hits per pass made by the UNM project. It should be emphasized that the combat reports at present available are not complete enough to make accurate deductions from.

3. In view of the facts stated in the preceding paragraphs, it is recommended that the stripped B-29 airplane be given a combat trial in operations which can utilize its advantages, with personnel trained in the special techniques which should be used with this type of airplane. It is believed that the advent of the new Japanese high-speed, high-altitude fighters makes the use of any B-29 under conditions of possible nose attack extremely dangerous.

II. Appraisal of the Method of Analysis

1. The undersigned spent eleven days in consultation with Dr. E. J. Workman, Dr. R. E. Holzer, Dr. G. T. Pelsor and Dr. W. D. Crozier of the Physics Department, University of New Mexico, and in study of the analyses made by this group. Dr. Hassler Whitney of the Applied Mathematics Panel, NDRC, was available for three days of consultation and has concurred in the conclusions of the present report. Dr. Whitney's knowledge of the aerial gunnery problem and the GFC system and general





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suggestions were enormously helpful to the undersigned.

III. Turret Film Analysis

1. The Workman Group determined average angular gun errors and standard deviations of these errors both in the plane of action and perpendicular to the plane of action by examination of and computation from movie films which photographed fighter aircraft from each of the five turrets on the B-29. A total of 426 measurements of error were obtained, and except for nose attacks, it is considered that a sufficiently large sample was used to make the conclusions entirely sound. (Further tests of nose attacks are being run, with a view to recommending optimum procedures to be followed by nose gunners, since it is nearly obvious that the CFC computer in present use afford a very small probability of obtaining hits on nose attacks.)

2. Errors entered into the measurement of gun position errors in several ways:

a. The distant reference points which were used to determine the motion of the fighter airplane relative to the bomber were, of course, not actually stationary with regard to the bomber. An average correction was made for the motion of these reference points relative to the bomber assuming the reference points were at a distance of approximately 10 miles, and a small error--not over 3 mils--enters from this source.

b. The personnel employed in analyzing the turret film were unable exactly to measure the range of the fighter airplane. Tests were conducted to measure their accuracy, using film which showed aircraft at fixed ranges on the ground. From these tests it was determined that the maximum error in range is about 10% of the correct range. No correction was made for this error except to fit a smoothed curve to the values of range obtained at various points throughout the films for one fighter position.

c. Speeds of the cameras (GSAP 17 mm and 35 mm cameras) were not constant, owing to differences in temperature, applied voltages, and (in the case of fighter cameras) load factors. Tests were run in the laboratory with various voltages, load factors artificially applied to the cameras, and voltages. The maximum deviation from the assumed rate of 16 frames per second was found to be 5%.

(1) It was found by the undersigned that the maximum error to be expected from the combined affects of b. and c. above is 20 mils. This will occur on beam shots, the total error varying roughly as the sine of the angle off. The average error, of course, will be smaller than 20 mils and has been guessed to be approximately 10 mils on the beam.

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(2) After determination of the average error (bias) and standard deviation of the error for various angles off around the airplane the average number of hits per pass was calculated by standard statistical techniques. These have been described in the Interim Report in considerable detail; no fault has been found with them. It is thought, however, that the time of fire for the bomber turrets, which is approximately .8 seconds for nose attacks (increasing to 4 seconds for tail attacks), is probably too small and that the bomber turrets should be given at least as much time for firing as the fighter is allowed in the analysis. In this way the bomber has been placed at a disadvantage. Futhermore, it has been assumed that only one turret on the bomber will fire against a given pass.

(3) The behavior of the CFC system is extraordinarily erratic. It is difficult to derive from study of UNM tests any pattern of error. This undoubtedly arises because of widely varying errors in tracking and ranging by the operators. It is thought that modified sights, which will improve tracking and ranging, will do a great deal to rectify the difficulties at present inherent in the CFC system. The UNM group have various devices in mind to accomplish this. No modified sight, however, can do very much to help on nose attacks, where the attack is so brief that the computer does not have time to build up an adequate lead.

## IV. Description of Fighter Analysis

1. Computation of the expected number of hits per pass by fighters attacking a B-29 was carried out by a different method from that used in computing expected bomber hits. As the bomber presents a much larger target than the fighter, it was thought advisable actually to place the pattern of the fighter's bullets about the fighter's aiming point and to estimate the percentage of that pattern which lay on the bomber. This, of course, is different from the method used with the bomber's projectiles, which were assumed to be uniformly distributed over the area of the fighter. Specifically, at every fifth frame of film taken from the attacking fighter, it was calculated where the fighter was aiming at the time when a bullet arriving at the bomber at the given frame was fired. A correction was made on this aiming point for the apparent trail of the fighter's bullets caused by his angle of incidence and curvature of path. On this corrected aiming point a template was placed, which showed the expected bullet pattern for the range in question and for a standard P-47 harmonization. A very large number of fighter passes were used, and, except for nose passes, it is thought that a statistically reliable sample showing percentage of hits per successful pass was obtained.

2. It is believed that the final fighter results giving number of expected hits per fighter hour of attack are too high. It was assumed by UNM in making this calculation that every pass would be successful,



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whereas in a considerable portion of attacks made the fighters did not get on the target at all. In some cases their aim was so badly off that they did not get the bomber within the field of view of their cameras during any part of the pass.

3. It is recognized that performance of Japanese fighter aircraft and personnel will almost certainly be inferior to performance of the P-47 aircraft and personnel which were used in the UNM tests. First, the Japanese do not as yet have in quantity operation a fighter comparable in performance with the P-47D aircraft which were used in the test. (It is to be expected, however, that in the future first line Japanese Army and Navy fighters will appear having top speeds in excess of 425 miles per hour, heavy armament, and good armor protection for the pilot.) Second, during the whole course of the war against Japan, Japanese pilots, with the exception of a few Navy squadrons, have shown themselves inexpert in aerial gunnery, as opposed to aerobatics, whereas the USAAF pilots used in the UNM tests are the pick of the experienced combat fighter pilots in the Second Air Force. Third, typical Japanese fighter aircraft armament consists of a total of 4 to 6 guns--4 20 mm, and 2 7.7 mm, 2 20 mm and 2 12.7 mm, etc.--whereas the P-47 aircraft were assumed to be firing 8 caliber 0.50 machine guns. These three facts, together with the spurious advantage mentioned in the preceding paragraph, combine to make the probable Japanese opposition much less effective than the opposition predicted for the P-47's attacking B-29's. This has been brought out very well in combat, where it has been found that the numbers of enemy aircraft knocked down were in good agreement with predicted results, while the number of bombers knocked down was much smaller than would have been expected from the UNM tests.

4. Comparison of the UNM tests with combat results was made for seven missions of XX Bomber Command. The tactical mission reports from XX Bomber Command list the number of fighter passes reported from each angle around the clock. These are subject to enormous inaccuracies, but were used since they are the only data available in the United States. From the UNM tests the average number of hits registered on the fighter per pass are known and, given the number of passes from each angle, one can compute, using a Poisson distribution, the expected number of fighters which will receive no hits, one hit, two hits, three hits, and so on. It was assumed that fighters receiving one, two, or three hits, would be in the categories of damaged or probably destroyed, and fighters receiving four or more hits would be in the category of destroyed. The fighters expected to be in the two categories of damaged or probably destroyed and destroyed, were compared with the results actually claimed by combat gunners. The results were found to be in good agreement, the computed totals usually being greater than the reported totals. On one occasion when a solitary F-13 photo aircraft underwent 12 passes by enemy aircraft destroying 7 and damaging 2 more, the claimed results are far in excess

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of what would be expected on the basis of UNM tests. In this it is not known how the B-29 personnel were employing their armament, nor how close the enemy aircraft came, both of which considerations are important in calculating the expected number of enemy aircraft shot down. It is recommended that an effort be made to obtain more accurate and detailed information from the operational Commands concerning fighter attacks and bomber defense.

EDWIN HEWITT
OAD Consultant

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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6 February 45

MEMORANDUM TO CONFERENCE ON FORMATION DEFENSE,
Pasadena, California.

Subject : Formation Defense.

1. The Twentieth Air Force is now bombing Japan from formations of twelve B-29s employing interplane spacings, turret controls and restrictions as to areas of search and fire as prescribed to XX Bomber Command Tactical Doctrine. It is the desire of the Twentieth Air Force that this doctrine be carefully evaluated so that, as Japanese air opposition grows, every feasible step will be taken to insure the maximum defense of our formations.

2. 2. Accordingly, it is requested that the Committee now meeting in Pasadena study the currently used formation, and submit to the Twentieth Air Force its recommendations as to means of improving B-29 Formation defense. It is hoped that this study will combine the firepower measurement techniques developed at the Mount Wilson Observatory with Current knowledge of CFC system accuracy, practical experience regarding formation flying and combat gunnery, and intelligence concerning enemy performance, tactics, and capabilities in such a way that sound answers can be given to the following questions:

a. Taking the 12 plane formation as presently prescribed, what is the relative firepower it can deliver to various parts of the sphere surrounding the formation? Against what directions of attack is it particular strong or weak?

b. Based on fighter capabilities, enemy tactics, and CFC accuracy, against what directions of attack is it most important to concentrate our defensive firepower? What zones require less protection?

c. What changes in the presently briefed areas of search and fire would afford greater protection against attacks on the formation's most vulnerable areas? How should turret exchanges be used to mass defense against various types of attack?

d. What changes in the presently prescribe interplane specings would afford greater protection against attacks on the formations most vulnerable areas? What sacrifice of protection is incurred when the formations is flown less tightly than prescribed, -- say, when its breadth and length is doubled?

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e. If operational difficulties prevent the assembly of balanced 12 plane formations, what doctrines should govern the spacing; turret assignments, and briefed areas of search and fire for smaller fromations?

f. What other recommendations can be made to improve the defense of B-29 formations?

3. Colonel William P. Fisher, Deputy Chief of Staff and Dr. Richard G. Gettell, Operations Analyst, are designated as the representatives of the Twentieth Air Force at this Conference. Colonel Fisher will convene the Conference, explain the purpose thereof, and thereafter Dr. Gettell will act as Chairman and Coordinator.

LAURIS NORSTAD
Brigadier General, U. S. Army
Chief of Staff

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13 Feb '45

MEMORANDUM TO: DR. ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

Subject: Operations Analysis Division Studied on Fighter Attacks against the B-29 and Use of the General Electric CFC against Fighter Attacks

1. At the present time, very little is known of the courses actually flown by fighters in shooting at B-29 airplanes. Most research, both military and civilian, on bomber defense, has been based on the very serious assumption that the attacking fighter flies a mathematically exact curve which will yield hits on the bomber during the whole attack. For several months, I have believed that fighters, owing to the difficult problems the pilot has in aiming, the large size of his target, and variations in speed which the pilot can employ, can and do fly curved which yield hits but which do not even approximate the pur suit curves encountered in theoretical discussions. This belief became conviction, especially with regard to attacks on the B-29, during two weeks' temporary duty during December 1944 at the University of New Mexico, where a considerable body of data had been accumulated on fighter attacks made on B-29's at varicus air speeds and altitudes. The data tabulated on fighter courses indicated amazing deviations from standard theory, in that the deflections required by the bomber to hit the fighter obeyed no known law.

2. At the same time, it became clear that the General Electric CFC system does not furnish correct deflections for hitting nose attacks, owing to the long time (three to five seconds) required for the computer to build up a lead and the extreme brevity of nose attacks (at most three seconds). For this reason, I believed that it would be much better for the gunner to putythe computer at standby and put in his own deflections, using the gun sight simply as a pointing device, since the remote control system for the turret works very well indeed. In order to formulate simple rules for the gunner to use against nose attacks, it was naturally necessary to know what deflection are necessary against nose attacks, and to this end some 125 nose attacks were made by P-47D-30 airplanes against B-29 airplanes flying about 300 MPH TAS at 24,000 feet. Of these, approximately 85 were completely analyzable, and we have at present for these courses, a record of leads taken by the fighter, his exact course relative to the B-29, and the deflections necessary from the bomber in order to hit the fighter. On this basis, it will be possible to set up simple deflection rules which

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will yield a few hits on the fighter for nearly every fighter pass.

3. I believe that a further contribution to the operations of the Twentieth Air Force can be made by collecting and analyzing data on fighter attack courses, deflections taken by the fighter, and deflections necessary for the bomber to hit the fighter, for beam and tail attacks as well as nose attacks and all operational altitudes: 19,000 feet, 24,000 feet and 30,000 feet. Modifications in the use of the CFC system are undoubtedly indicated for beam attacks, and possibly for tail attacks; but we cannot develop any rules for gunners to use until we know what really goes on in the air.

4. Furthermore, personnel of the Second Air Force and engineers of the General Electric Company have developed modifications for the present computer which will give it a much smaller solution time and may make it quite suitable for use against nose attacks. The behavior of this modified computer should be checked against genuine fighter courses and it should also be subjected to a good air test against real attacks. The hits obtained in this way should be compared with the hits obtained by a gunner using his own deflections, so that the better system may be made available as quickly as possible, for B-29 combat units.

5. I believe that the work described in paragraphs 3 and 4 above is of such urgency, considering in particular the importance of nose defense of the B-29, that no avoidable delay should be countenanced in its prosecution. I believe that there will be a delay of about six months in the procurement of usable data if this project is turned over to Eglin Field, since the type of film analysis employed requires a trained crew of about 12 persons, in addition to supervisory personnel, scientific personnel who can make judgements from the results obtained, and computing help (who are available from AMP in New York City).

6. I further believe that the University of New Mexico is the institution best suited to carry on this work for a two-month period, which should suffice for the completion of the projects described above; and that no further difficulties will arise through the publication of unsound opinions.

EDWIN HEWITT
Operations Analyst

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MEMORANDUM TO: COLONEL J. T. POSEY
DC/S, Combat Operations

Subject: Defensive Fire Power of B-29 Airplanes

1. Have submitted the attached file to Dr. Edwin Hewitt for his comments. Here are his comments:

> "I think that the idea of a training film as such for B-29 crews on WHAT FIGHTERS LOOK LIKE would be enormously valuable. I talked with quite a few B-29 people at Alamogordo, and they emphasized again and again the point that crews being trained for combat never see real honest fighter attacks. Most of them get their first view of fighters when somebody is shooting at them. I understand that this is partly because of liaison difficulties between the bomber boys and the fighter boys in the Second Air Force and partly because the fighter pilots used are OTU personnel who are just getting checked out on the airplane. A ten or fifteen minute film on fighter characteristics (without the usual eye wash and rah rah, but with simple facts in it) would be a very good thing. I'd expand the present Mt. Wilson program considerably, if I were doing it".

2. I concur.

ROBERT L. STEARNS
Operations Analysis Division
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D.C.

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By authority of
CF 20th Air Force
15 Jan 45 RLS

13 Jan 45

MEMORANDUM FOR THE CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: Report on "Tests Relative to the Defense and Tactical Use of the B-29" of 15 Nov 1944, by Department of Physics, University of New Mexico.

1. Summary and conclusions. A careful study was made by the undersigned of the method used by the UNM project in evaluating the defensive power of the B-29 airplane. This method has been found valid in most essential respects, and is considered to give an accurate analysis of what can be expected from B-29 defensive gunnery.

The alleged discrepancy between combat claims from XX Bomber Command for enemy aircraft destroyed, probably destroyed, and damaged, and the results obtained by the UNM group, has been subjected to statistical analysis. From this it appears that the combat claims, so far as can be determined from information in Tactical Mission Reports, are generally in good agreement with the prediction of average hits per pass made by the UNM project. It should be emphasized that the combat reports at present available are not complete enough to make accurate deductions from.

In view of the facts stated in the preceding paragraphs, it is recommended that the stripped B-29 airplane be given a combat trial in operations which can utilize its advantages, with personnel trained in the special techniques which should be used with this type of airplane. It is believed that the advent of the new Japanese high-speed, high altitude fighters makes the use of any B-29, under conditions of possible nose attack, extremely dangerous.

2. Appraisal of the method of analysis. The undersigned spent eleven days in consultation with Dr. E. J. Workman, Dr. R. E. Holzer, Dr. G. T. Pelsor and Dr. W.D. Crozier of the Physics Department, University of New Mexico, and in study of the analyses made by this group. Dr. Hassler Whitney of the Applied Mathematics Panel, NDRC, was available for three days of consultation and has concurred in the conclusions of the present report. Dr. Whitney's knowledge of the aerial gunnery problem and the CFC system and general suggestions were enormously helpful to the undersigned.

3. Turret film analysis. The Workman Group determined average angular gun errors and standard deviations of these errors both in the plane of action and perpendicular to the plane of action by examina-

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tion of and computation from movie films which photographed fighter aircraft from each of the five turrets on the B-29. A total of 426 measurements of error were obtained, and except for nose attacks, it is considered that a sufficiently large sample was used to make the conclusions entirely sound. (Further tests of nose attacks are being run, with a view to recommending optimum procedures to be followed by nose gunners, since it is nearly obvious that the CFC computer in present use afford a very small probability of obtaining hits on nose attacks.)

Errors entered into the measurement of gun position errors in several ways:

a. The distant reference points which were used to determine the motion of the fighter airplane relative to the bomber were, of course, not actually stationary with regard to the bomber. An average correction was made for the motion of these reference points relative to the bomber assuming the reference points were at a distance of approximately 10 miles, and a small error - not over 3 miles - enters from this source.

b. The personnel employed in analyzing the turret film were unable exactly to measure the range of the fighter airplane. Tests were conducted to measure their accuracy, using film which showed aircraft at fixed ranges on the ground. From these tests it was determined that the maximum error in range is about 10% of the correct range. No correction was made for this error except to fit a smoothed curve to the values of range obtained at various points throughout the films for one fighter position.

c. Speeds of the cameras (GSAP 17 mm and 35 mm cameras) were not constant, owing to differences in temperature, applied voltages, and (in the case of fighter cameras) load factors. Tests were run in the laboratory with various voltages, load factors artificially applied to the cameras, and voltages. The maximum deviation from the assumed rate of 16 frames per second was found to be 5%.

It was found by the undersigned that the maximum error to be expected from the combined affects of b) and c) above is 20 mils. This will occur on beam shots, the total error varying roughly as the sine of the angle off. The average error, of course, will be smaller than 20 mils and has been guessed to be approximately 10 mils on the beam.

After determination of the average error (bias) and standard deviation of the error for various angles off around the airplane the average number of hits per pass was calculated by standard statistical techniques. These have been described in the Interim Report in considerable detail; no fault has been found with them. It is thought, however, that the time of fire for the bomber turrets, which is

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approximately .8 seconds for nose attacks (increasing to 4 seconds for tail attacks), is probably too small and that the bomber turrets should be given at least as much time for firing as the fighter is allowed in the analysis. In this way the bomber has been placed at a disadvantage. Furthermore, it has been assumed that only one turret on the bomber will fire against a given pass.

The behavior of the CFC system is extraordinarily erratic. It is difficult to derive from study of UNM tests any pattern of error. This undoubtedly arises because of widely varying errors in tracking and ranging by the operators. It is thought that modified sights, which will improve tracking and ranging, will do a great deal to rectify the difficulties at present inherent in the CFC system. The UNM group have various devices in mind to accomplish this. No modified sight, however, can do very much to help on nose attacks, where the attack is so brief that the computer does not have time to build up an adequate lead.

4. Description of fighter analysis. Computation of the expected number of hits per pass by fighters attacking a B-29 was carried out by a different method from that used in computing expected bomber hits. As the bomber presents a much larger target than the fighter, it was thought advisable actually to place the pattern of the fighter's bullets about the fighter's aiming point and to estimate the percentage of that pattern which lay on the bomber. This, of course, is different from the method used with the bomber's projectiles, which were assumed to be uniformly distributed over the area of the fighter. Specifically, at every fifth frame of film taken from the attacking fighter, it was calculated where the fighter was aiming at the time when a bullet arriving at the bomber at the given frame was fired. A correction was made on this aiming point for the apparent trail of the fighter's bullets caused by his angle of incidence and curvature of path. On this corrected aiming point a template was placed, which showed the expected bullet pattern for the range in question and for a standard P-47 harmonization. A very large number of fighter passes were used, and, except for nose passes, it is thought that a statistically reliable sample showing percentage of hits per successful pass was obtained.

It is believed that the final fighter results giving number of expected hits per fighter hour of attack are too high. It was assumed by UNM in making this calculation that every pass would be successful, whereas in a considerable portion of attacks made the fighters did not get on the target at all. In some cases their aim was so badly off that they did not get the bomber within the field of view of their cameras during any part of the pass.

It is recognized that performance of Japanese fighter aircraft and personnel will almost certainly be inferior to performance of the P-47 aircraft and personnel which were used in the UNM tests. First, the Japanese do not as yet have in quantity operation, a fighter comparable in performance with the P47D aircraft which were used in the



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test. (It is to be expected, however, that in the future first line Japanese Army and Navy fighters will appear having top speeds in excess of 425 miles per hour, heavy armament, and good armor protection for the pilot). Second, during the whole course of the war against Japan, Japanese pilots, with the exception of a few Navy squadrons, have shown themselves inexpert in aerial gunnery, as opposed to aerobatics, whereas the USAAF pilots used in the UNM tests are the pick of the experienced combat fighter pilots in the Second Air Force. Third, typical Japanese fighter aircraft armament consists of a total of 4 to 6 guns - 4 20mm, and 2 7.7 mm, 2 20 mm and 2 12.7 mm, etc. - whereas the P-47 aircraft were assumed to be firing 8 caliber 0.50 machine guns. These three facts, together with the spurious advantage mentioned in the preceding paragraph, combine to make the probable Japanese opposition much less effective than the opposition predicted for the P-47s attacking B-29s. This has been brought out very well in combat, where it has been found that the numbers of enemy aircraft knocked down were in good agreement with predicted results, while the number of bombers knocked down was much smaller than would have been expected from the UNM tests.

Comparison of the UNM tests with combat results was made for seven missions of XX Bomber Command. The tactical mission reports from XX Bomber Command list the number of fighter passes reported from each angle around the clock. These are subject to enormous inaccuracies, but were used since they are the only data available in the United States. From the UNM tests the average number of hits registered on the fighter per pass are known and, given the number of passes from each angle, one can compute, using a Poisson distribution, the expected number of fighters which will receive no hits, one hit, two hits, three hits, and so on. It was assumed that fighters receiving one, two, or three hits would be in the categories of damaged or probably destroyed, and fighters receiving four or more hits would be in the category of destroyed. The fighters expected to be in the two categories of damaged or probably destroyed and destroyed, were compared with the results actually claimed by combat gunners. The results were found to be in good agreement, the computed totals usually being greater than the reported totals. On one occasion when a solitary F-13 photo aircraft underwent 12 passes by enemy aircraft, destroying 7 and damaging 2 more, the claimed results are far in excess of what would be expected on the basis of UNM tests. In this it is not known how the B-29 personnel were employing their armament, nor how close the enemy aircraft came, both of which considerations are important in calculating the expected number of enemy aircraft shot down. It is recommended that an effort be made to obtain more accurate and detailed information from the operational Commands concerning fighter attacks and bomber defense.

Approved:

s/Robert L. Stearns
ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

EDWIN HEWITT
Operations Analyst

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Request For Tests of B-29 Defense Against Nose Attacks

AC/AS, O C & R — 16 Mar 45

Chief of Staff, Twentieth Air Force — 1 RLS/ma/72993

1. Combat reports from XX and XXI Bomber Commands verify the results of Tests conducted in the Zone of the Interior showing that the CFC system does not provide accurate fire to protect B-29s against nose attacks. Moreover combat experience shows that, up to the present, the most dangerous and most common Japanese fighter attack originates from the nose region.

2. As alternatives to the normal use of the computing sight, several proposals have been advanced, designed as stop-gap techniques for immediate adoption in the field, to provide for increased effectiveness in our defense against nose attacks:

a. Use the computer in its present form, but set the range imput to 250 yards when the fighter is at 1500-1600 yards range, and then track and fire in the normal manner. (This technique is currently prescribed by overseas Commands).

b. Place the computer on stand-by, and instruct the gunner to put in his own deflections on the basis of rules which have been determined from studying nose attacks made by U. S. fighter aircraft. (This proposal has been made by Dr. Hewitt, Operations Analyst, Twentieth Air Force).

c. Modify the computer by changing one resistance so that the computer will set up deflections more quickly. (This suggestion has been made by representatives of Feneral Electric).

d. Modify the computer by exchanging motors and resistances, so that it becomes a semi-own speed, semi-rate type sight for which ranging is not required. (This proposal has been made by Dr. William L. Duren Jr., Operations Analyst, Second Air Force).

3. It is desired that the four proposals enumerated in Paragraph 2 be evaluated with respect to the probability of hits made by trained gunners against actual air attack, so that the method which is most efficient in shooting down fighters can be adopted in training and for combat operations. It is desired that this project be given a high priority, as it is of urgent operational importance.

4. It is suggested that Dr. Edwin Hewitt, Dr. William L. Duren Jr. and a representative of the General Electric Company be used as technical advisors for this project.

LAURIS NORSTAD
Brigadier General, U. S. Army.

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HEADQUARTERS TWENTIETH AIR FORCE
OPERATIONS ANALYSIS DIVISION

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28 April 1945

TESTS OF B-29 COMPUTERS FOR NOSE DEFENSE
ON THE UNIVERSITY OF TEXAS TESTING MACHINE

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Summary and Recommendations

1. In the past two months, a large number of proposals have been received for improving the performance of the B-29 fire control system against nose attacks. These proposals have involved (a) modifying the techniques employed, using the present computer, (b) modifying the computer itself in various ways, (c) dispensing with the computer and using position firing.

2. Tests have been carried out by the University of Texas War Research Laboratory to determine which proposal will give best results in combat. It is recognized that the machine used to measure gun errors and the statistical technique used to compute hit probabilities cannot exactly duplicate combat conditions or give reliable estimates of how many fighters will be shot down out of a given number attacking. Nevertheless, the results of the tests are so clear-cut that a definite recommendation for combat use can be made at once. Furthermore, flight test data taken by University of New Mexico under Project AC-92 corroborate the main findings.

3. The tests have shown that the method prescribed in XXI Bomber Command Tactical Doctrine is enormously inferior to several simpler methods of using the equipment. Two methods give excellent results on the University of Texas tests; and these two best proposals are to be tested in the near future at the Army Air Forces Proving Ground Command.

4. In order immediately to improve combat performance of the B-29 in nose defense, it is strongly recommended that the SOP prescribed in XXI Bomber Command Tactical Doctrine be discarded and that, pending completion of the Proving Ground

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Command tests, the operational Commands in the Twentieth Air Force use the computer with speeded up total output motors as recommended by the General Electric Company and 900 yards fixed range set into the computer. It is a surprising fact that, owing to the dynamic response of the computer, 900 yards fixed range gives hits for a substantial time at ranges under 900 yards. It is clear that this measure will result in vastly improved nose defense of B-29 airplanes.

I. Details of the proposals. The following proposals for use of the B-29 fire control equipment against nose attacks were tested by the War Research Laboratory, University of Texas:

1. Use the normal computer with continuous manual ranging (this proposal was tested to give an idea of optimum performance of the equipment as designed by the General Electric Company).
2. Speed up the total correction motors so that the low speed is about 60 mils per second and the high speed is about 100 mils per second change in correction. Use continuous manual ranging. (This proposal has been made by the General Electric Company).
3. Use the computer speeded up as in proposal 2, further modified so that the total correction motors run in high speed while the gunner is not firing and run in low speed while the gunner is firing. Use continuous manual ranging. The gunner is to allow time for the computer to get on before firing and thus get the benefit of the high speed motors. (This proposal has been made by Drs. M. R. Hestenes and D. C. Lewis, of the Applied Mathematics Group, Columbia University).
4. Use the present computer. Set range at 1200 yards, and when the enemy aircraft is at 1600 yards, spin the range from 1200 yards to 250 yards. Track and fire normally during the rest of the pass. (This proposal is prescribed in XXI Bomber Command Tactical Doctrine).



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5. Use the computer speeded up as in proposal 2. Set range at 1200 yards. When the enemy aircraft is at 1200 yards, spin the range from 1000 yards to 250 yards. (This proposal was tested in the belief that it represents the best possible performance with spin back technique).

6. Use the computer speeded up as in proposal 2. Keep range fixed at 800 yards throughout the pass. (This proposal has been made by a number of persons).

7. Use the computer speeded up as in proposal 2. Keep range fixed at 900 yards throughout the attack. (This proposal was tested to compare it with 800 yards and 1000 yards fixed range).

8. Use the computer speeded up as in proposal 2. Keep range fixed at 1000 yards throughout the attack. (This proposal was tested to compare it with 800 yards and 900 yards fixed range).

9. Use the computer speeded up as in proposal 2, and turn it into a partial own speed-partial rate sight. By setting parallax for turret-sight distance $37\frac{1}{2}$ feet and 250 yards range, obtain an own speed correction of 50 sin $\theta$ in mils. Set ballistic range input to 716.6 yards, and set time of flight to .6 seconds. No ranging is required. (This proposal has been made by Dr. W. L. Duren, Operations Analysis Section, Hq. 2nd Air Force).

10. Put the computer at standby, and use modified position firing rules based on flight tests of P-47s attacking B-29s. (This proposal has been made by Dr. Edwin Hewitt, Operations Analysis Division, Hq. Twentieth Air Force).

In addition to the above listed proposals, three others were given limited test, but owing to their totally unpromising character, were not carried through completely.

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II. Details of the test. The tests of the proposals listed in Section I were carried out by personnel of the War Research Laboratory, University of Texas, operating under Division 7 of NDRC. The tests were carried out with speed and accuracy. The undersigned were present as observers and assistants during the tests, together with Mr. Burns S. Hansen, of the General Electric Company, who carried out the various modifications proposed and checked the computers for proper operation.

The machine used in the tests is a mechanism which can duplicate azimuth and elevation movements, as well as range, for any fixed fighter course. The gunner sees a motion picture of a fighter aircraft, which moves in azimuth and elevation in a prescribed manner. He tracks (and ranges where necessary) this target with the sighting equipment used in the air. His sight is connected to whatever computer in being tested, which in turn transmits the lead information to a standard turret. By a system of gimbals, the turret gun position is compared with the correct gun position (which is known for the fixed fighter course being duplicated by the machine). Errors in azimuth*, elevation, and range (where range is used) are automatically recorded on photographic paper, and can be studied within a few minutes after the test has been made. The errors committed by the machine in measuring gun position errors are of the order of one to two mils.

Six gunners were used in the test. These men are assigned to the War Research Laboratory, University of Texas, on temporary duty from Laredo Army Air Base, Laredo, Texas. All of them have had combat experience, five having completed tours of duty in the ETO and one having flown 13 missions before being shot down. Three were turret gunners on B-17 airplanes, two were turret gunners on B-24 airplanes, and one was a turret gunner on a B-26 airplane. They have been at the University of Texas for about four months, and have had an enormous amount of

* Actually traverse instead of azimuth error.



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practice in tracking and ranging with the General Electric pedestal sight, in which records of errors were immediately available, so that the gunners know what errors they are making. It is believed that their performance is a sample of the best that can be done with the pedestal sight.

Four different attack courses were used in the test, designed as courses 5, 6, 7, and 8. In these courses, the bomber speed is 300 MPH TAS, the altitude about 28,000 feet density altitude, and the fighter speed 300 MPH TAS at the beginning of the attack. The fighter speed remains constant in courses 5 and 7, and increases about 25 feet per second in courses 6 and 8. The fighter leads taken in courses 6 and 8 were computed for 30 mm. Mauser ammunition, and the bomber leads used in all four courses were computed for cal. .50 AP M2 ammunition. Courses 5 and 7 are pure pursuit courses, in the sense that the fighter is assumed to be flying with its line of flight always directed at the bomber with no angle of attack correction. Courses 6 and 8 are aerodynamic lead pursuit courses, in the sense that the fighter is assumed always to be giving the bomber the correct lead, a correction being made for angle of attack of the fighter. A brief description of the four courses follows:

Course 5

Pure pursuit in a plane tilted 45° to the horizontal. When range is 1200 yards, angle off bomber's nose is 15°. Initial range is 1500 yards.

Course 6

Aerodynamic lead pursuit with plane of action tilted by varying angles through the attack. When range is 1200 yards, angle off bomber's nose is 15° and tilt angle of plane of action is 45°. Initial range is 1300 yards.

Course 7

Pure pursuit in a plane tilted 45°. When range is 1200 yards, angle off bomber's nose is 20°. Initial range is 1500 yards.

Course 8

Aerodynamic lead pursuit with plane of action tilted by varying angles throughout the attack. When range is 1200 yards, angle off bomber's nose is 20° and tilt angle of plane of action is 45°. Initial range is 1200 yards.



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It is realized that 28,000 feet is somewhat higher than normal B-29 operating altitudes, but, when true airspeed is fixed, the only effect of altitude is slightly to change time of flight and ballistic corrections. Accordingly, a test at 28,000 feet gives a reliable indication of what to expect at lower altitudes. Also, the fighter speed is somewhat lower than what would be expected in combat. Increased fighter speed would make a briefer course, but would decrease the leads from the bomber, and therefore the total aiming problem presented here is not unlike that found with true operational fighter speeds. Finally, it may be thought that since fighters attacking B-29s seldom if ever fly pursuit courses in the ordinary sense, but rake the bomber from front to back or back to front, a test of the fire control equipment against pure and aerodynamic lead pursuit courses is meaningless. Bomber's leads for such theoretical courses and bomber's leads for a large number of courses actually flown in the air have been carefully compared, and the theoretical leads are found to form a good mean of the leads for real courses, which vary widely among themselves.

In testing the various proposals enumerated in Section I, each gunner made four runs with each proposal against each course. In proposals 1, 2, and 3, which involve manual ranging, two additional runs were made by each gunner with correct range being fed into the computer.

In testing proposal 3, the gunners were instructed to hold their fire for the first two seconds of the attack, so that the computer would have time to build up a lead with the total correction motor running at high speed. On courses 7 and 8, stop-watch records were kept of the time between the start of the attack and the point where firing began. The mean delay was very close to two seconds. On courses 5 and 6, the photographic record taken of the gunner's performance shows when firing occurs, and it will be seen that the delay is about 2 seconds in each case.



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In testing proposal 4, the gunners were instructed to spin the range from 1200 yards to 250 yards when the attack began, for courses 5 and 7, i. e., at 1500 yards instead of 1600 yards. This limitation was unavoidable using the courses available for test. For courses 6 and 8, which begin at 1200 yards, the gunners were instructed to spin the range from 1200 yards to 250 yards 1½ seconds before the enemy aircraft appeared, but after the spot where the target would appear had started to move. This was done by using a stop-watch. This spin-back duplicates closely the technique used with courses 5 and 7.

Proposals 5 to 9, inclusive, were tested without using any special techniques. Proposal 10 was tested without giving the gunners any special opportunity to practice, since they were already familiar with the courses and are expert in free gunnery.

III. Results of the the tests.

1. Normal computer with manual ranging. Although the tactical doctrines of the XX Bomber Command and the XXI Bomber Command recognize that manual ranging on fast closing nose attacks is virtually impossible, it was tested along with the other proposals for comparison. The test gunners were able to obtain better results with manual ranging than with the spin back techniques. (See Appendix 1, Figures 1, 3, 5, and 7). However, this does not indicate a return to manual ranging, for the test gunners were experts and their conditions of operation were much more favorable than those obtaining in combat. Furthermore, it is important to take note of the two control runs each gunner made in which correct range was fed automatically to the computer. The results were not much better than with manual operation and definitely inferior to some of the fixed range proposals. This means that automatic radar range cannot solve the problem, for the computer does not build up correct leads for nose attacks, even with correct range.

2. The speeded output computer as recommended by the General Electric Company. In recommending that the output motors be speeded up from the present



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35 mils per second to 60 mils per second, the General Electric Company engineers feared that the higher speeds would cause the computer to "hunt" too much. The test results indicate that the computer has satisfactory stability at the higher speeds and that improvement in nose defense will be effected by adopting the higher regular speed of 60 mils per second. With the higher speeds, automatic correct range was advantageous, but still not so good as the simpler fixed range proposals except for range less than 500 yards, which is not considered to be the range band in which it is most important to get hits against nose attacks.

3. The Hestenes-Lewis proposal. The proposal that the computer run at very high speed (100 mils per second) until it has time to get on, followed by dropping into regular speed as soon as the triggers were depressed was given a highly favorable test, as the gunners were unusually proficient in estimating the getting-on time of two seconds. Despite this, the results were bad. The conclusion, substantiated by later tests of a slightly different character, is that any use of the 100 mil per second speed causes the computer performance to deteriorate. Projected later tests of the Hestenes-Lewis proposal with different speeds may show some advantage from it. However, trigger control of motor speed is likely to result in the computer's being low speed continuously from 1500 yards in, as that is the way gunners tend to fire.

4. The present XXI Bomber Command "spin-back" technique. This is one of the very worst techniques. The guns are consistently behind, with error of the order of thirty-five mils. (See Appendix 1, Figures 1, 3, 5, and 7). This does not mean that no hits will be scored by this technique. In fact, very crude estimates of the lethal hit probability indicate that it should shoot down about one attacker in fifteen.

5. The XX Bomber Command spin-back technique with speeded output. The original spin-back ranging technique as used in XX Bomber Command is superior to the advance range spin-back of XXI Bomber Command. In this test, it was

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tried with the speeded output computer discussed in proposal 2. It tends to underlead badly both early and late in the pass, often making two or more erratic cross overs to the overleading side and back somewhere in the middle of the course. It is characterized by wide fluctuations in error and is inferior to the fixed range proposals.

6. Fixed range of 800 yards. Surprisingly good shooting can be done without any modification of the computer other than speeding the output motors to 60 mils per second as recommended by the General Electric Company (proposal 2) and fixing the range. Best results are obtained with fixed range settings of 800 to 1000 Yds. (See Appendix 1, Figures 2, 4, 6, and 8). Sustained good shooting occurs well within the range at which the computer is set and the computer often stays on target for one or more whole seconds. In effect, this procedure takes advantage of the computer lag to stay on after the target has come inside the range fixed in the computer.

7. Fixed range of 900 yards. This is the best fixed range according to the Texas Machine tests comparing 800, 900 and 1000 yards. Also, an estimate based on flight data from eighty-two nose passes flown by P-47s against B-29s indicate that the best fixed range setting is about 900 yards. (See Second Air Force Operations Analysis Section Report No. 18, "An Available Fast Nose Computer for the B-29," Inclosure 4).

8. Fixed range of 1000 yards. This fixed range still gives good results, although the hits are moved out in range. This would be an improvement if it were not accomplished at the cost of overleading systematically too soon in the attack to be tolerated.

9. Partial own-speed and rate computation, fixed range. This proposal requires no new parts but requires that a resetting of the parallax and the time of flight units be carefully accomplished in the field. This is a disadvantage as



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compared with the other fixed range proposals. In the test, this modified computer was not adjusted to fit courses on the cams but was tested with calibration from previous flight data. It gave results almost as good as the best fixed range, 900 yards. Possibly in air test it will be found to have merit, especially when gar-port fire data come into the test.

10. Modified position firing. The position firing proposal with fire gunner leads especially adapted to B-29 nose attacks yielded very poor results. It was only a little better than the XXI Bomber Command spin back technique in the test. It is clear from observation of the data that the computer can place the guns in the line of apparent motion much more accurately than can a gunner, so that when the computer gets the right amount of lead it is usually on target, whereas the gunner usually gets the right amount of lead at a time when he is off in direction.

11. Comparison of fixed range proposals in hit probability figures. The four fixed range proposals are sufficiently close in apparent accuracy to necessitate the use of some objective measure of success to rank them. The figure employed was a hit probability measure calculated by Dr. L. A. Jeffress of the University of Texas and based on a method developed by the Applied Mathematics Panel. The figures, which are to be taken as relative at best, are calculated as the probability that a single shot will make a lethal hit. They take account of gun dispersion and the decrease in bullet density due to range. The present XXI Bomber Command technique was put in for comparison.

A table showing these hit probabilities appears on the next page.

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| Proposal Number | Designation | Per Cent Hit Probability |
|---|---|---|
| 6 | 800 yard fixed range | 6.21 |
| 7 | 900 yard fixed range | 7.90 |
| 8 | 1000 yard fixed range | 6.54 |
| 9 | 2 AF partial own speed | 7.24 |
| 4 | XXI B. C. spin back | 0.26 |

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APPENDIX

Graphical Records. The graphical records reproduced on the following pages show one gunner's performance against each of the four courses employed with each of the 10 proposals tested. At the bottom of each graph is a scale showing range in hundreds of yards at that point on the graph. At the left of each graph is a scale showing error (azimuth* and elevation) in mils. The vertical lines on the graphs are time intervals, each of $\frac{1}{25}$ second. The curves marked "E" on each graph show gun elevation error in mils, the curves marked "T" show gun azimuth error in mils, while the curves marked "R" are a measure of the difference between the correct range and the range put in by the gunner. In proposals involving fixed ranges, the range record is simply a smooth curve. For the elevation error curves, negative errors are measured upward, i. e., if the elevation curve is above (below) the base line, there is too little (too much) elevation lead. For the azimuth error curves, negative errors are measured downward, i. e., if the azimuth error curve is below (above) the base line, there is too little (too much) azimuth lead.

* Actually traverse instead of azimuth.

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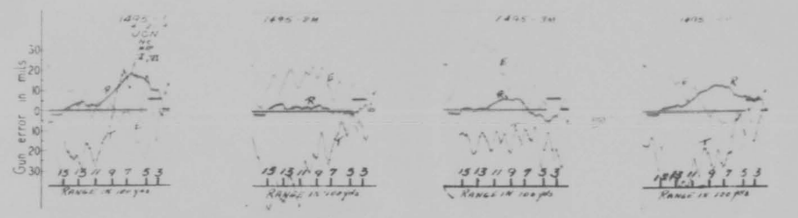
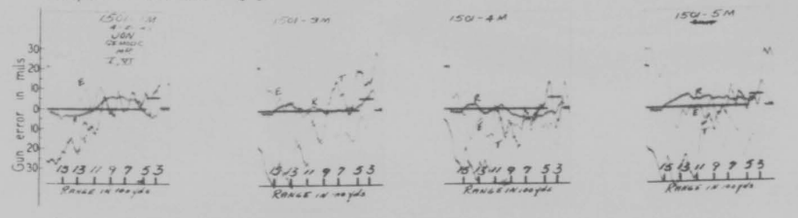
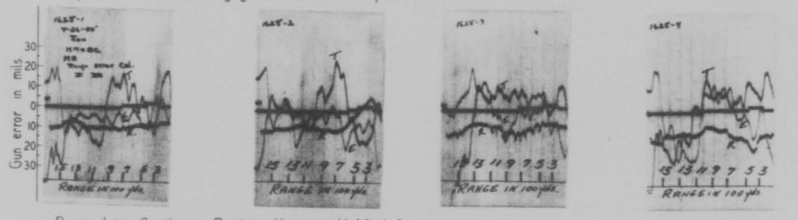


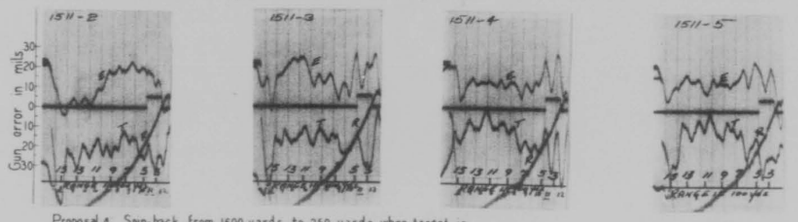

Proposal 1: Continuous Ranging, Normal Computer.



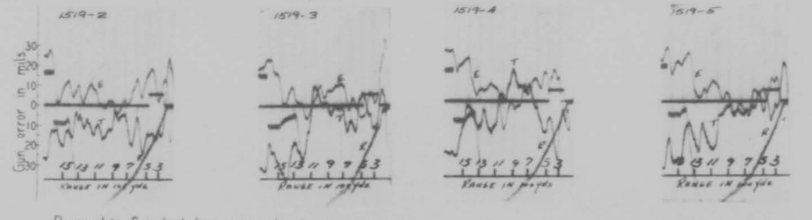

Proposal 2: Continuous Ranging, G-E Modified Computer.




Proposal 3: Continuous Ranging, Hestenes Modified Computer.




Proposal 4: Spin-back from 1600 yards to 250 yards when target is at 1200 yards, Normal Computer.




Proposal 5: Spin-back from 1200 yards when target is at 1200 yards, G-E Modified Computer.

COURSE 5: PURE NOSE PURSUIT IN 45° PLANE

Figure 1

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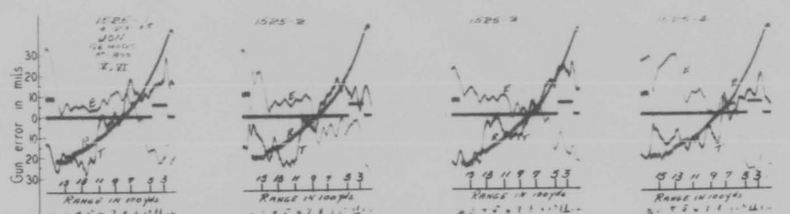
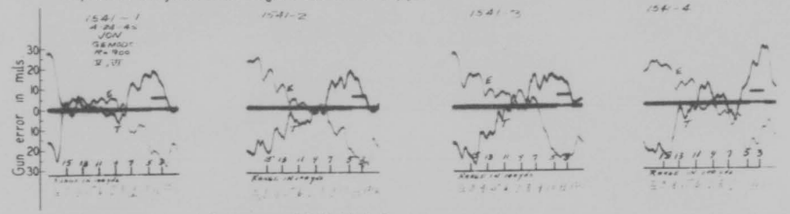
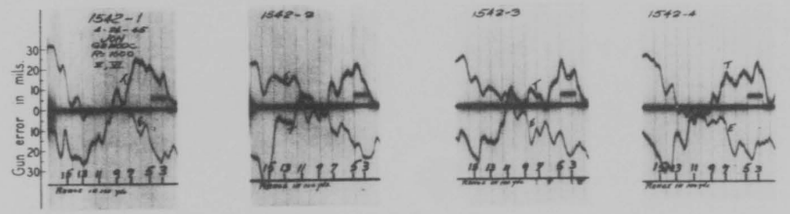


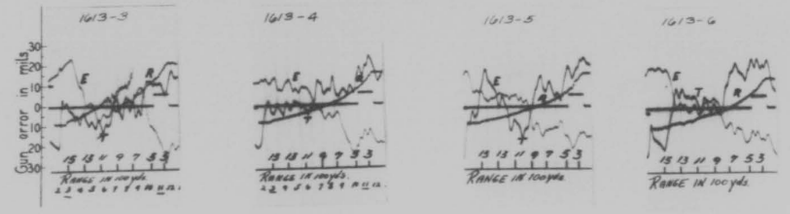

Proposal 6: 800 yards fixed range, G-E Modified Computer.



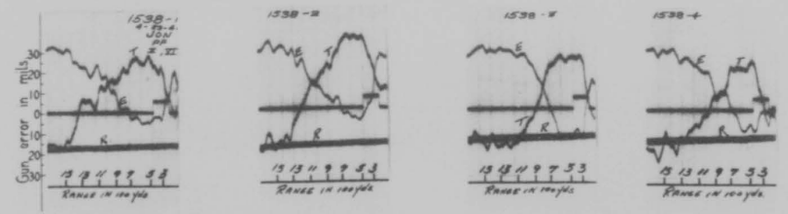

Proposal 7: 900 yards fixed range, G-E Modified Computer.




Proposal 8: 1000 yards fixed range, G-E Modified Computer.




Proposal 9: No ranging, Duren Modified Computer.




Proposal 10: Hewitt position firing rules.

COURSE 5: PURE NOSE PURSUIT IN 45° PLANE

Figure 2.

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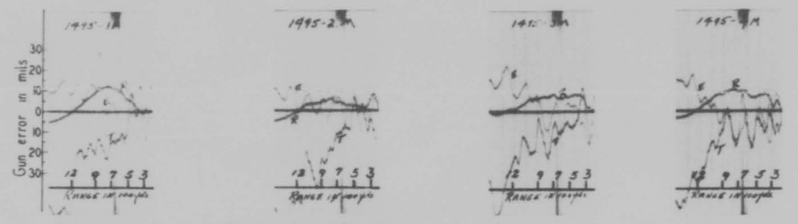
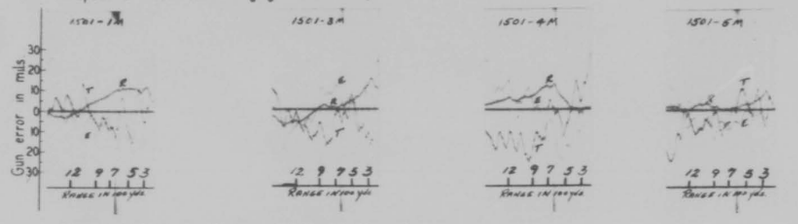
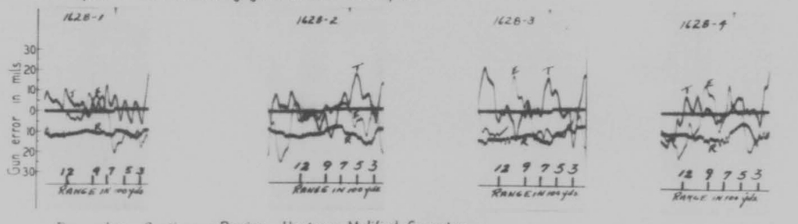


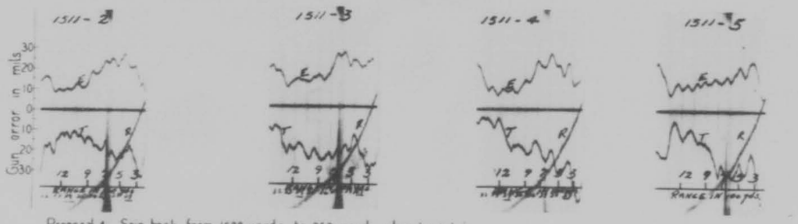

Proposal 1: Continuous Ranging, Normal Computer.



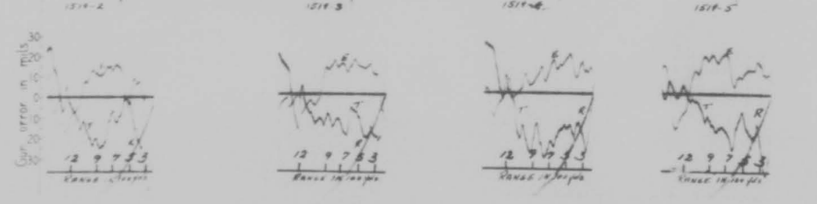

Proposal 2: Continuous Ranging, G-E Modified Computer.




Proposal 3: Continuous Ranging, Hestenes Modified Computer.




Proposal 4: Spin-back from 1600 yards to 250 yards when target is at 1200 yards, Normal Computer.




Proposal 5: Spin-back from 1200 yards when target is at 1200 yards, G-E Modified Computer.

COURSE 6: AERODYNAMIC NOSE PURSUIT IN 45° PLANE

Figure 3

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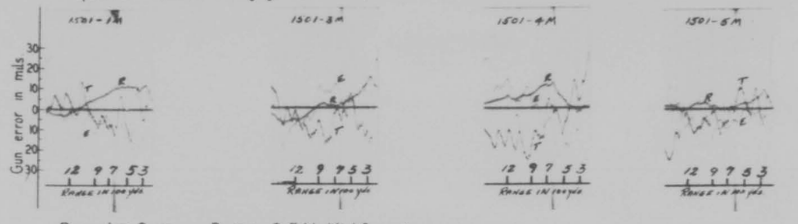
Proposal 1: Continuous Ranging, Normal Computer.

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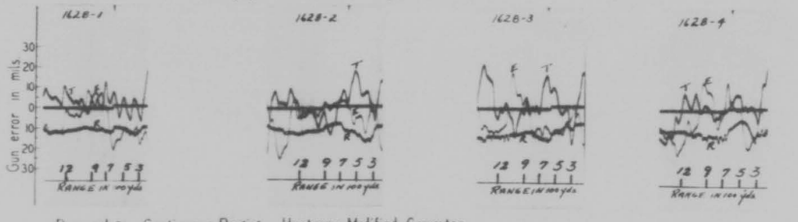


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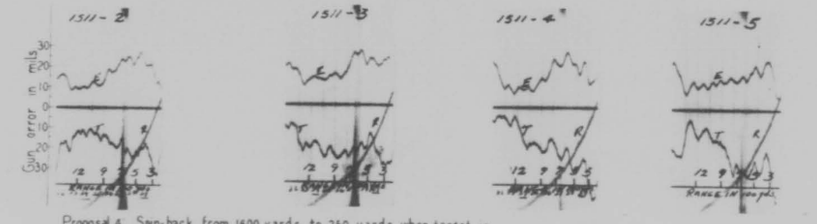
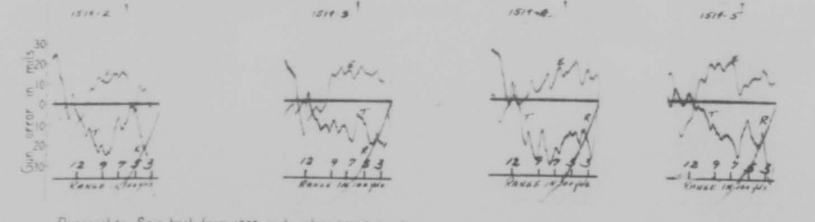



Proposal 4: Spin-back from 1600 yards to 250 yards when target is at 1200 yards, Normal Computer.




Proposal 5: Spin-back from 1200 yards when target is at 1200 yards, G-E Modified Computer.

COURSE 6 AERODYNAMIC NOSE PURSUIT IN 45° PLANE

Figure 3

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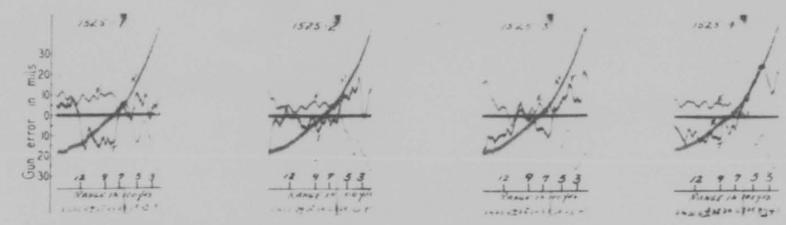
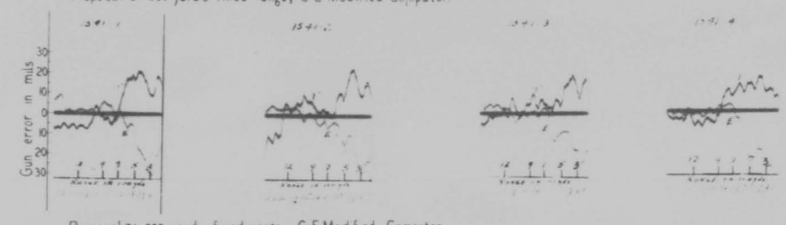



Proposal 6: 800 yards fixed range, G-E Modified Computer.

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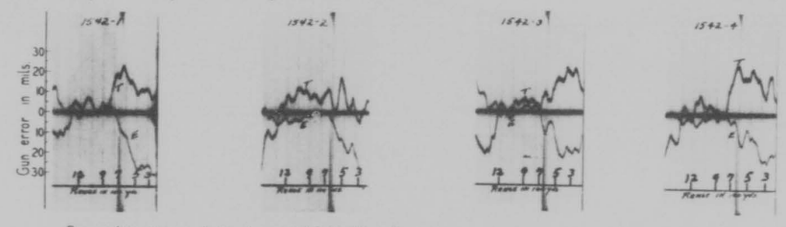


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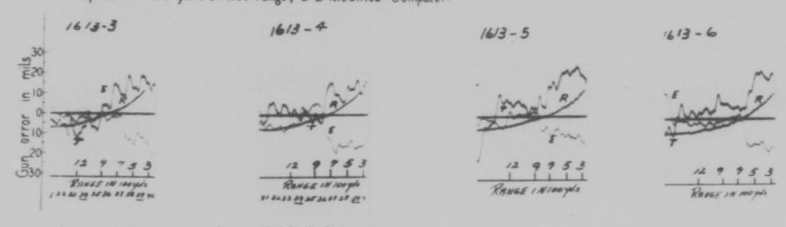


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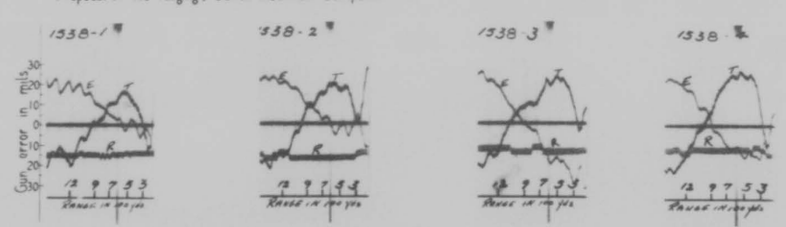


Proposal 10: Hewitt position firing rules.

COURSE 6: AERODYNAMIC NOSE PURSUIT IN 45° PLANE

Figure 4.

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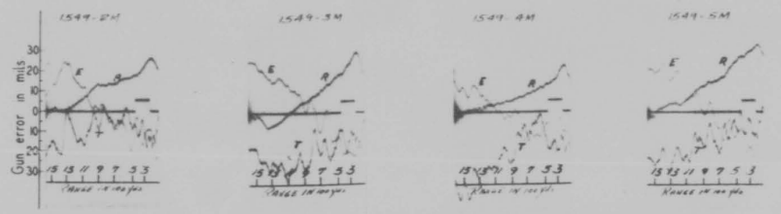


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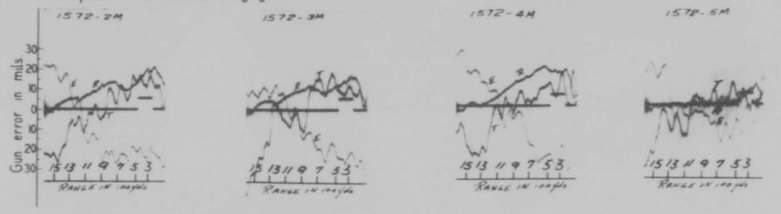


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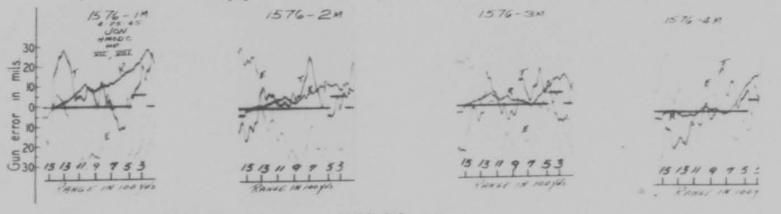


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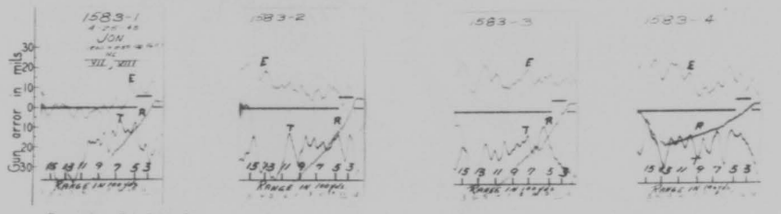


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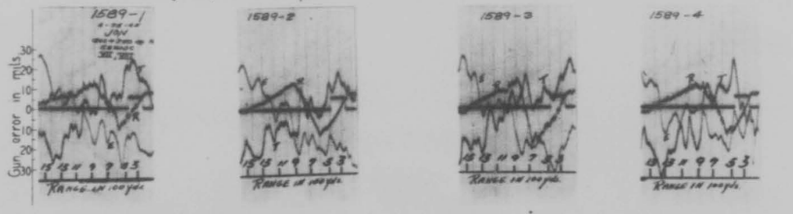


Proposal 5: Spin-back from 1200 yards when target is at 1200 yards, G-E Modified Computer.

COURSE 7: PURE NOSE PURSUIT

Figure 5.

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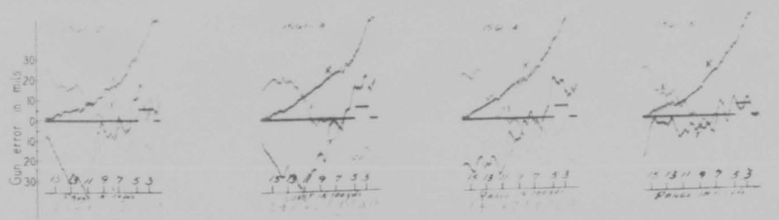
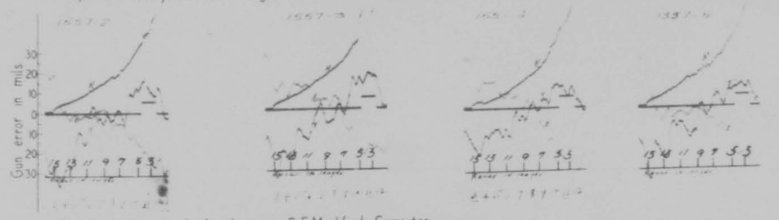



Proposal 6: 800 yards fixed range, G-E Modified Computer.

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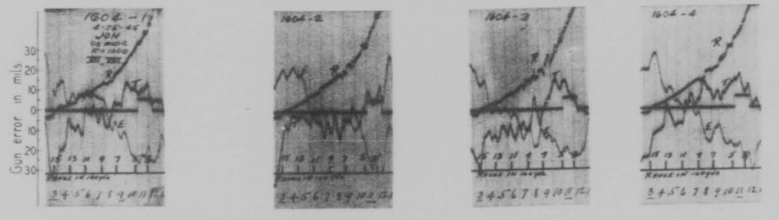
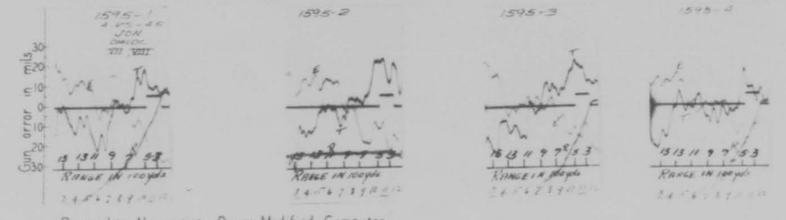



Proposal 8: 1000 yards fixed range, G-E Modified Computer.

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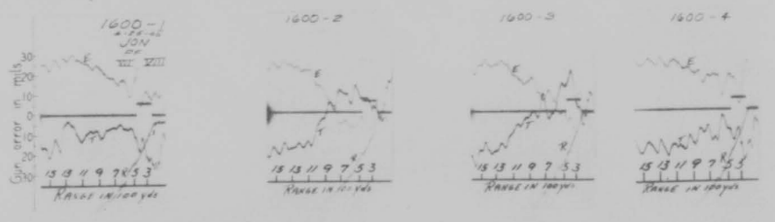


Proposal 10: Hewitt position firing rules.

COURSE 1: PURE NOSE PURSUIT

Figure 6

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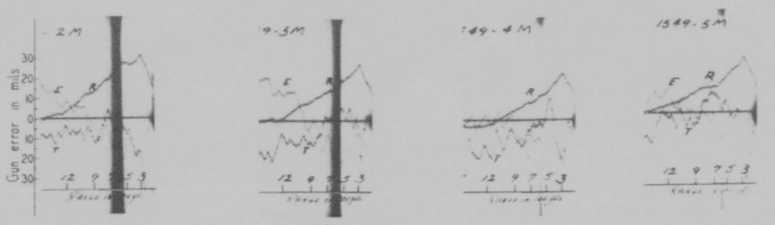


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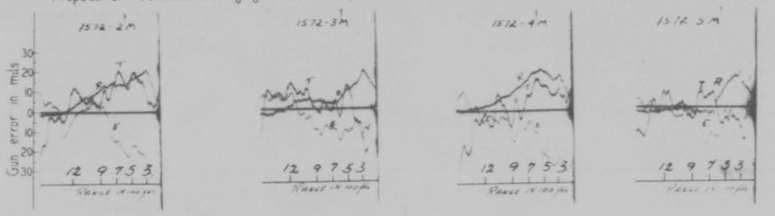


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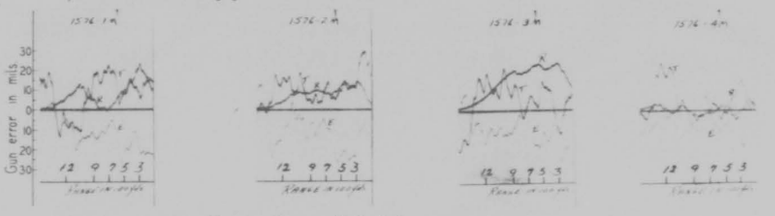


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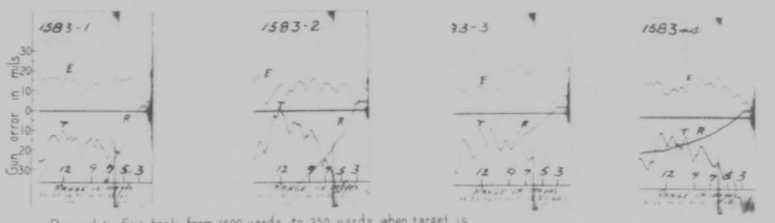


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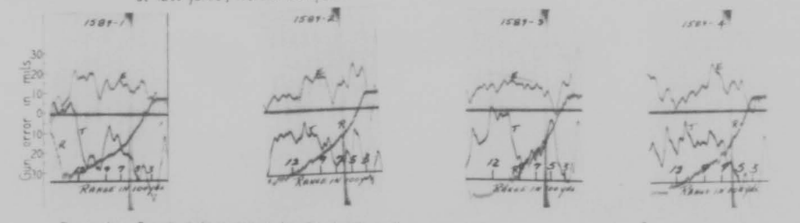


Proposal 5. Spin-back from 1200 yards when target is at 1200 yards, G-E Modified Computer.

COURSE 8. AERODYNAMIC NOSE PURSUIT. Figure 7.

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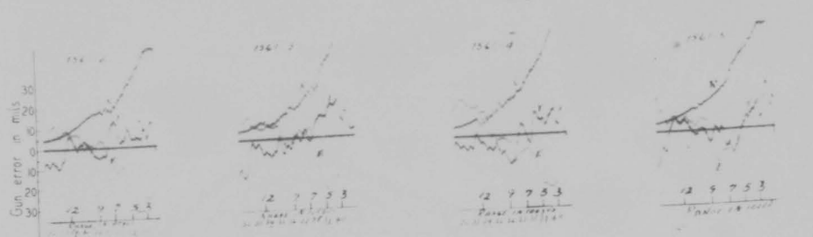


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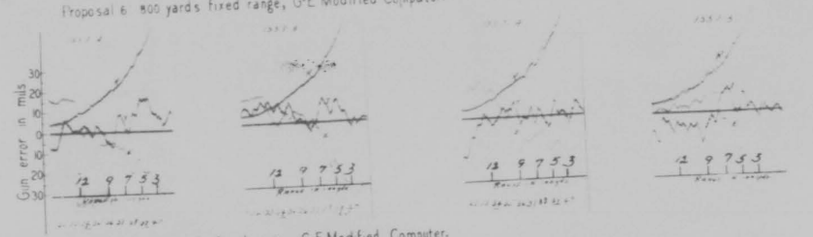


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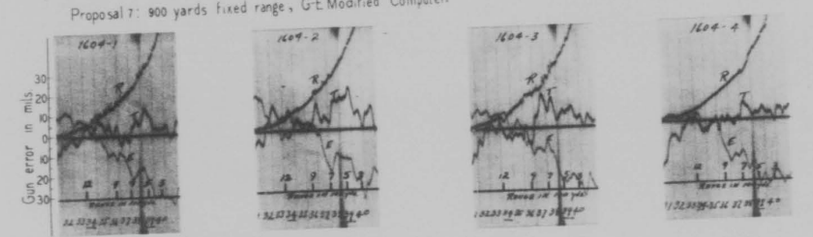


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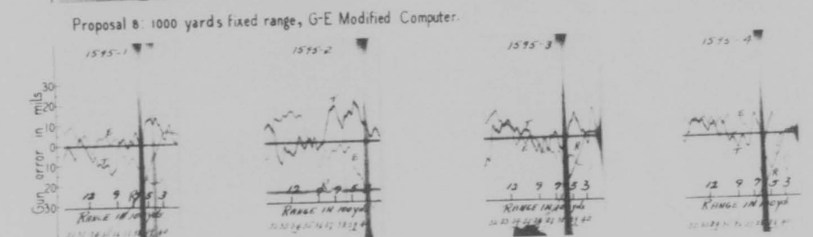


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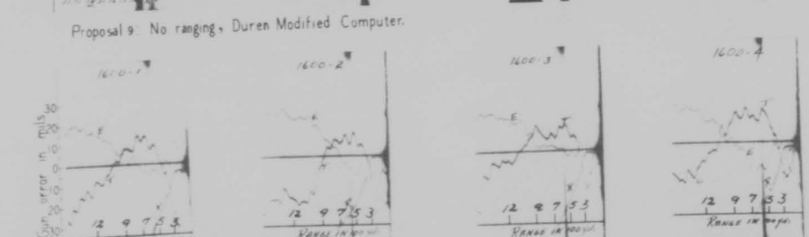


Proposal 10: Hewitt position firing rules.

COURSE 8. AERODYNAMIC NOSE PURSUIT Figure 6

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21 May 45

MEMORANDUM FOR : DR. ROBERT L. STEARNS, Chief
Operation Analysis Division, Twentieth Air Force

SUBJECT : Present Status of B-29 Harmonization Devices

The writer spent some time with Dr. Theodore Dunham, Jr., Dr. Baker, Dr. Fry, Dr. Caldwell, Dr. Flood, Dr. Peterson, Mr. Kissam and Mr. Thralls at Cambridge and Princeton. At the latter place the prism and wire methods were set up and operated. As a result of these discussions and demonstrations the following facts were established.

1. The wire method being developed by Dr. Peterson, under N.D.R.C. contract through Dr. Dunham, gives promise of being the fastest, both in its actual use in harmonization, and also ease of manufacture. It is based upon the simple expedient of establishing two perpendicular lines to a tightly stretched wire. One of these lines pass through the bore of the gun and the other through the sight reticle. The apparatus is built into a standard Bausch and Lomb 6 x 30 binoculars. It has successfully harmonized a B-29.

The present weakness is the poor stand provided for holding the instrument. This has been radically re-designed and is under construction at Trenton. The new stand is estimated to be finished in three weeks but is at rather low priority.

2. The prism methon was devised and built at the University of Rochester under N.D.R.C. contract. It is a more complex optical scheme for making equal two alternate interior angles of transversal cutting across two lines which latter are thereby made parallel. One of these pass through the gun bore and the other the sight. It has sucessfully harmonized a B-29. Its shortcoming at present is again a readlily adjustable stand. It is a more difficult and delicate instrument to build, and clearly requires manufacture by an optical goods shop.

3. Various mirros methods are being promulgated and one has been adopted by the Army in its sodification centers. They all require a large framework for mounting of morrors, careful adjustment and constant checking of the mirrors by transit man for parallelism, and at present stage of development do not appear to be as practica ble for field use as either of the two former methods.

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RECOMMENDATIONS

1. It is strongly urged that Dr. Dunham be encouraged by Dr. Stearns to undertake construction immediately of 12 (6sets) binocular modifications for the wire method of harmonization. These binoculars can be obtained, on requisition, from the Frankfort Arsenal and Dr. Flood can arrange for the Shop work to be carrier out around Trenton. It is estimated a month, or six weeks will be required.

Twelve of the presently developed adjustable stands should be started at the same time. During the time of construction, four to six inlisted men who have worked on B-29 harmonization should undergo a short training program with Kissam and Thralls on learning the application of this particular device so that they could take the finished apparatur into the XXI Bomber Command and be ready to immediately set up regular harmonization checks of the bombers. It would be a mistake to not send a thoroughly trained crew to ensure adequate utlization of the equipment. The techniques involved are simple but require an appreciation of the accuracy involved which can only be required by proper training. One would not send untrained men to operate a bomber, neither should one expect to skip the training period in this, even more, delicate field of accurate harmonization.

2. A few more of the prism heads should be made. These can probably be made at Mount Wilson Observatory under their optical instrument development contract. Mr. Nichols, their chief instrument designer, has seen the optical heads, knows they can make them, and Dr. Dunham could probably make the necessary financial support through Dr. Walter Adams. This present suggestion is to avoud missing any bets on good alternative methods to the wire schemes. The extra expense involved is felt to be thoroughly justified on the basis of reducing the time necessary for adequate theater tests of these types of harmonization.

If development is continued solely on the basis of the present single pieces of each type, more time will be consumed in the testing program than the recommended procedure involves and if, at the end of this time, either method should be adopted by the XXI Bomber Command, then more pieces would have to be constructed.

The six sets of the wire method would give two to each of the 73rd, 313th and 314th Wings and the necessary additional trained crews of four men per device could be trained in turn by the single trained crew planned for in these recommendations.

DONALD H. LOUGHRIDGE
Operation Analyst

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SAVE

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

5 June 45

MEMORANDUM FOR : CHIEF OF STAFF, Twentieth Air Force

SUBJECT : Field Harmonization of B-29 Guns
(N.D.R.C. Project AC-127 Aircraft Harmonization Studies)

1. It will be recalled that one of the pressing problems at the headquarters of the XXI Bomber Command is that the Harmonization of the guns and sights, and the development of the adequate method of harmonization which can be employed in the hard stand positions of the aircraft.

2. Two methods are now being developed. One is known as the "prism" method and is being developed under the direction of Dr. Theodore Dunham, Jr,, Chief of Section 16.1 (Optical Instruments) of N.D.R.C. The other is known as the "wire" method and is being developed under the direction of Dean Kissam of the Engineering Department at Princeton. For your information, I am inclosing a memorandum prepared by Dr. Donald H. Loughbridge, of this Division, who has recently returned from the XXI Bomber Command headquarters, and who is familiar with this entire project.

3. A recent exchange of messages with the Headquarters of the XXI Bomber Command elicits a reply indicating great urgency, in the form of Cable No. AIMAT 0166, dated 3 May, the last paragraph of which indicated that the Command recommends the establishment of the highest priorty for the development of a method of harmonization which would provide two things: one, a reduction in the time required to carry out the procedure, and two, a method which will allow the airplane to be harmonized in every normal attitude at the parking hard stand.

4. The development work above referred to is progressing, but in order to expedite the activity to comply with the request of the Commanding General of the XXI Bomber Command, there is attached hereto an R & R prepared for the signature of the Chief of Staff which should give the necessary impetus to this project. It is requested that the R & R be signed and sent through the office of the AAF Liaison Officer with the N.D.R.C.

ROBERT L. STEARNS, Chief
Operations Analyst Division
Twentieth Air Force

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Harmonization of B-29 Guns(N.D.R.C. Project AC-127 Aircraft Harmonization Studies)

Army Air Forces Liaison Officer, Headquarters, AAF 7 June 45

Chief of Staff, Twentieth Air Force Dr. Stearns/ma/72993

1. Advices from the Commanding General of the III Bomber Command indicate the urgent necessity, at highest priority, for the developement of a system or systems, of harmonizations of B-29 guns which will enable the procedure to be handled with much greater speed than is now required, and to be done on the hard stand positions in the parking areas of the aircraft. There is attached hereto a memorandum describing the past and present status of this matter.

2. We are now informed that the followinf is the present status of the development of these procedures and devices:

a. That under Dr. Dunham's directions, drawings of the so called Rochester prisms have been completed and that work can now be undertaken on the immediate preparation of the equipment embracing their use.

b. That the Mount Wilson Observatory i n Pasadena has developed a method involving the use of prisms for the upper turrets and that this system is ready for manufacture of trial sets.

c. That the wire method now being developed at Princeton, under the direction of Dean Kissam, has been completed and trial sets will shortly be available.

d. That, in order to use any of the three systems described above, some type of stand is necessary. Two types of stands are now being developed; one by Dr. Peterson at M. I. T., designed for construction out of wood; another by Dean Kissam at Princeton, designed for construction out of metal.

e. It is desired that work be pushed to the completion of one of more of these methods as rapidly as possible, and when completed this headquarters be notified so that the subsequent stepq may then be taken:

(1) Prism (University of Rochester) 3
(2) Wire (M.I.T.) 6
(3) Bore-sight Mirror (M.Flood) 9

3. Six men (Three teams of two each) will be selected for training by the N.D.R.C. Project Personnel in the operation of the harmonization equipment, and when trained, will accompany the equipment to the appropriate bases of the XXI Bomber Command for field tests. The results of these tests will be promptly reported to the headquarters of the XXI Bomber Command, and requisitions for the full quantity of selected equipment will then follow.

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4. It will expedite the completion of this project if Air Force funds can be made available to O.S.R.D. for the necessary developmental purposes

5. It is beleived that the urgency of this requirement dictates that every effort be exerted to bring this matter to a successful conclusion as rapidly as possible.

LAURIS NORSTAD
Brigadier General, U.S. Army
Chief of Staff

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OPERATIONS ANALYSIS REPORT

SECRET
By Authority of
The CG, AAF
Date: 23 Oct 44
Initials: JJM

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Issuing Unit: Operations Analysis Section,
XX Air Force Headquarters

Title: A Lightweight Radar Computer
Combination for the B-29
R. C. T. System

Date: 23 October 1944

Identification: Memorandum
Dated 23 October 1944

Note: Operations Analysis Sections (designated in some theaters as Operational Research Sections) have been established in a number of Air Force Commands pursuant to a memorandum from CG AAF to All Air Force Commanders, dated 24 October 1942, approving this activity.

This is a report of one such Section. Information as to Operations Analysis Sections and reports can be obtained from Operations Analysis Division, Management Control, Headquarters, Army Air Forces, Washington, D. C.

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   - A. Description and Operation
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Appendix II Errors in Present R.C.T. System
Appendix III Windage Jump Compensation
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S E C R E T

# A Lightweight Radar Computer Combination for the B-29 R.C.T. Syatem

This material is presented for evaluation and possible use by persons concerned with the designing and engineering of Airbourne Fire Control Equipment. The writer wishes to apologize for its sketchy nature and requests that its inadequacies be considered in the light of the haste in which, of necessity, it was prepared.

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## 1. Abstract:

This report proposes a modification of the B-29 computer which will eliminate sufficient weight from the present system to compensate for the installation of existing radar ranging equipment. The radar computer combination should afford an accuracy of fire unattainable with present equipment. In addition to the factors of weight reduction, the modified computer has many additional refinements and advantages. It has one minor disadvantage.

## 2. Recommendation:

As a result of the proposals presented in this report it is recommended that a model of the computer be constructed immediately and that an investigation be made of possible radar computer installations.

## 3. Introduction:

The major defect of computing sights for airborne fire control has been the physiological difficulty for gunners under the stress of an attack to perform the operations required. Results from gunsight aiming point camera studies indicate that even experienced gunners do not have the high degree of coordination necessary to simultaneously range, track, and pull the trigger. In view of the rough information that is given to the computer, it is very questionable whether many of the refinements incorporated into present-day computers are of value. Automatic ranging by means of radar equipment, which may be available in several months, (ARO equipment) presents the outstanding possible method for improving gunnery accuracy. With such equipment the gunner's task is merely to track the target and press the trigger.

It has been the tendency to consider the ranging equipment under development as a separate component of the gunnery equipment whose function is to provide a shaft output which would feed the range into a standard computing sight. More recently, however, efforts are being made to integrate the computer with the ranging equipment to obtain an overall system containing a minimum of components. This report presents a possible way in which this may be achieved, especially in conjunction with the Remote Turrets on the B-29. The radar computer combination suggested should weigh less than the present computer alone. It achieves simplicity by the use of the very simple vector mechanism developed



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for Own Speed Sights, in conjunction with automatic ranging to deflect the sightline directly by the ballistic and parallax corrections. With the ballistics and parallax inserted into the sight, the computer need only feed the prediction to the differential selsyns. For this purpose the traverse rate gyro is converted to an azimuth rate gyro to give prediction directly in azimuth increment . The elevation gyro is unaltered. By modifying the computer in this fashion, approximately 4/5 of the mechanism is eliminated including all of the electro-mechanical follow-up systems required for ballistics and parallax. The following components of the present computer are unnecessary in the proposed change:

a. Azimuth and elevation Input Unit.
b. Windage input unit (Indicated Airspeed, Temperature and Altitude inputs).
c. Parallax unit.
d. Ballistics unit.
e. Pantograph.
f. Axis converter.
g. Potentiometer resolver.
h. Azimuth output unit.
i. Elevation output unit.
j. Servo Amplifier unit (all electronic components of computer).
k. Relay unit.

In place of these components is substituted a small mechanical unit mounted on the sight consisting of three cams mounted on two shafts whose angular position is determined by the range.

The prediction calculating component of the computer is also simplified by use of simple time of flight network in conjunction with the azimuth and elevation gyroscopes. The unit will be small enough to mount on or adjacent to the sight. Rather than use differential selsyns to transfer the prediction signal to the turrets, mechanical differentials are used to rotate the 1 and 31 speed sight selsyns through the correction angle. The sight and computer thus constitute a complete unit whose output, the selysn generator voltages, may be used to control any turret.

To summarize, the proposed modification has the following refinements and advantages over the present computer:

1. Its weight per computer is reduced by the elimination of approximately 100 lbs of elaborate electronic and mechanical equipment plus the weight of armor plate used to protect it.

2. Any sighting station may be used to control any turret.

3. Simple checks without additional equipment will indicate computer or radar set failure.

4. A simple short distance harmonization procedure is possible.





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5. A simple emergency Own Speed Sight is available should the radar set fail.

6. The system is adaptable to frangible bullets.

7. Compensation can be made quickly for minor ammunition changes and barrel wear.

8. Compensation is made for the temperature effect on muzzle velocity.

The system suffers one possible disadvantage in that the parallax correction for only one turret at a time is made. If two or more turrets are controlled, it is necessary to use an average parallax correction. This is perhaps an advantage in that it essentially provides a rectangular pattern having a long axis in the plane of action. Computers which use present range and rate to compute future position are truly accurate only for the case of rectilinear motion of the target or motion of the target in a circle about the bomber. Errors arise for other situations, in particular for pursuit courses. Because of this fact, a slight alteration of the prediction is generally made in the computer as an average compensation for pursuit attacks. This alteration serves on the average to make the computer somewhat inaccurate for other passes. In view of this and other theoretical errors, dispersion in the plane of action is desirable. The best type of pattern would be one having a long axis in the plane of action, and that is just what is obtained by using two turrets separated along the line of flight of the bomber by a finite distance.

4. Ballistic and Parallax Computer:

A. The ballistic and parallax computer is mounted atop a stationary post which lies along the vertical axis of the pedestal sight. The sight bar which supports the sight is pivoted at one end by means of a ball socket arrangement. Let O designate the intersection point of the two axes of the sight (See Fig. 1). Let the position of pivot point (ball) be designated P. The second pivot point of the sight bar is called Q. P is displaced by the Ballistic Parallax Computer a distance (x) parallel to the line of flight and a distance of (y) vertically, where x and y are determined by the computer to be just the amount necessary to allow for trail, gravity drop, horizontal parallax, and vertical parallax. Range is fed into the computer by means of a flexible cable from the ARO (automatic ranging) equipment. Three cams, a longitudinal parallax, a windage, and a vertical correction (for gravity and vertical parallax), are mounted on two shafts geared directly to the range input. These shafts are geared to rotate one complete cycle for the complete range handled, 0-1600 yards. There are three manual inputs into the computer:

a. The lateral parallax distance to the gun position under control.

b. The product $\rho V_i$ where $\rho$ is the relative air density, $V_i$ the indicated air speed of the bomber. This product may be quickly determined by a simple slide rule from the indicated airspeed, and the altitude. Correction is made for temperature





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by assuming a temperature altitude function.

c. The vertical parallax distance.

The ballistic parallax computer deflects the sight line from the gun line (assuming no prediction) by the extent of the ballistic and parallax corrections. These corrections can be shown to consist almost completely of two components:

a. A component in the plane of action given by A sin $\theta$ where $\theta$ is the angle off the line of flight of the sight line, and A is a coefficient whose value is given below.

b. A vertical component given by B sin Z when Z is the zenith angle of the sight line and B is a coefficient whose value is given below.

By examining Fig. 1, it is obvious that, to a good approximation, the sight bar is displaced from the normal sight axis in the plane of action an angle given by X/R sin $\theta$ and vertical angle given by Y/R sin z.

The function of the ballistics parallax computer is to make the necessary x and y displacements according to the range, indicated air speed, altitude, temperature, and parallax distances.

B. Analysis of Deflections: (See definitions in Appendix)

The trail angle is given by:

$$\lambda_w \quad \frac{v_{ED}}{V_1} \frac{W_2}{V_2} \left(1 + \frac{v_{pd}}{V_3} + \frac{W_2}{V_1} \cos\theta\right) \sin\theta$$

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by use of the relation: $\sqrt{P}\, W_{1B} = W_{1B}$ This may be written as:

$$\frac{VD}{V_s^2}\left(1+\frac{\nu\rho D}{V_s}+\frac{W_2}{2V_s}\cdots\right)\sqrt{P}\, W_{1B}\sin\theta$$

As the trail correction is always small, it is possible to make certain approximations in the treatment of the higher order terms. For convenience, $\frac{W_2}{2V_s}\cos\theta$ is regarded as a constant having an average value of $\overline{\frac{W_2}{2V_s}\cos\theta}$ for each sight position. Similarly, $\nu\rho D/V_s$, in the parenthesis, is also treated as a constant equal to its average value. The displacement of the follower necessary for trail compensation may then be given by:

$$x = C_1(D + C_2 D_2)\sqrt{P}\, W_{1B}$$

where $C_1 = \frac{V}{V_s^2}\left(1+\overline{\frac{W_2}{2V_s}\cos\theta}\right)R$ and $C_2 = \frac{\overline{VP}}{V_0}$

This equation is mechanized by means of a cam which has the following equation (in cylindrical coordinates):

$$r = r_0 + (D + C_2 D^2)C_1 F(z)$$

where $F(z)$ is a convenient function of $\sqrt{P}\, W_{1B}$

Parallax.

The angular allowance for parallax is given by $P/D \sin\theta$

A three-dimensional cam having an equation in cylindrical coordinates given by $r = r_0 + \frac{P(z)}{D}$ where a convenient function of z is used.

Vertical Correction.

Gravity drop. The allowance for gravity drop and vertical parallax is given by: $\frac{gD}{2V_s^2}\left(1+\frac{4}{3}\frac{\nu\rho D}{V_s}\right)\sin z$ and $\frac{g}{D}\sin z$ respectively.

These two corrections may be inserted on a single three-dimensional cam having the equation:

$$r = r_0 - \frac{gD}{2V_s^2}\left(1+\overline{\frac{4}{3}\frac{\nu\rho D}{V_s}}\right) - \frac{g(z)}{D}$$

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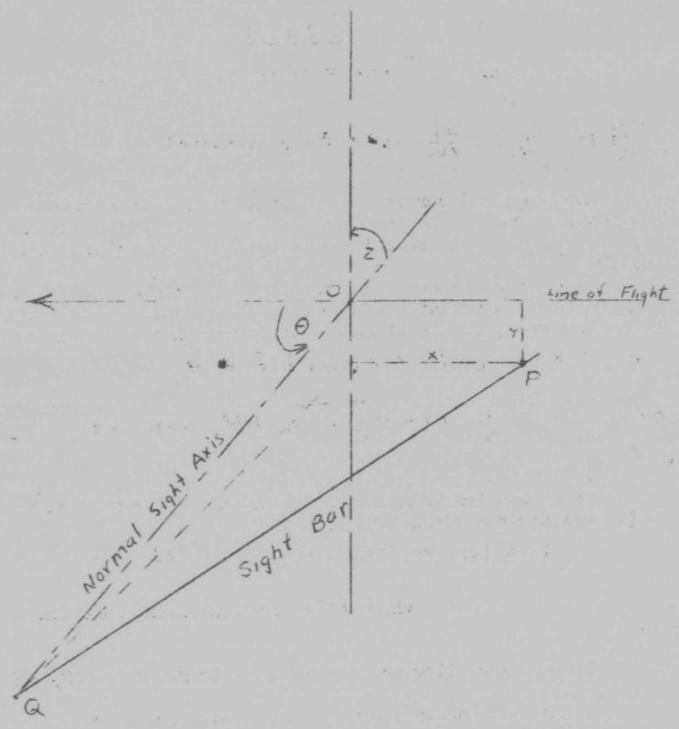


Fig. 1

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C. Components of Ballistics and Parallax Computer:

a. Parallax cam.
b. Trail cam.
c. Vertical correction cam.
d. Trail follow-up.
e. Parallax follow-up.
f. Compression springs.
g. Bevel gear (range gear train).
h. Bevel gear (range gear train).
i. Constraining ring for small bevel gear.
j. Slotted shaft.
k. Slotted shaft bearings.
l. Large gear.
m. Small gear.
n. Parallax distance dial.
o. Windage dial.
p. Vertical parallax distance dial.
q. Vertical follow-up.
r. Emergency compensating sight dial
s. Emergency compensating sight pivot support.
t. Flexible shaft range input.

Groups:

a. Parallax cam assembly:

1. Cam.
2. Cam shaft.
3. Cam shaft bevel gear.
4. Slotted shaft bevel gear.
5. Trail follower dial.
6. Constraining ring and frame.

b. Ballistics assembly:

1. Vertical correction cam.
2. Cam shaft.
3. Cam shaft bevel gear.
4. Slotted shaft bevel gear.
5. Vertical parallax dial.
6. Constraining ring and frame.

D. Operation of Computer:

The computer contains three cams: (a) the parallax, (b) the windage, and (c) the vertical correction. The range gear train is so designed that one complete revolution of each shaft corresponds to a change in range from 0 - 1600 yards. The flexible cable input proportional to range from the A. R. O. equipment feeds into the reduction gear train, an arrangement which reduces the error caused by the twisting of the flexible cable. The position of the parallax follower, (a), is adjusted by the dial setting (m) according to the parallax distance. The entire parallax cam assembly is displaced a linear distance determined by the position of the cam. This assembly displaces in turn the ballistic assembly. By means of the trail cam and follower, whose position depends on dial (o), an additional lateral displacement is imparted to the ballistic assembly. This gives a net lateral displacement to compensate for trail and parallax. A vertical follower constrained by the ballistic assembly frame is spring loaded to bear on the vertical correction cam. The vertical follower with the ball is thus raised or lowered according to the range input and the vertical parallax distance set in dial (p).

If the sight bar is five inches long, then a .005" displacement will produce a one-mil deflection angle. Assuming a plus or minus one mil tolerance for ballistic and parallax correction, then the cam and follow-up need be kept within .0025" tolerance, a value which can be maintained in production without great difficulty.

The sight which now serves merely as an aiming pointer should be made as light and compact as possible.





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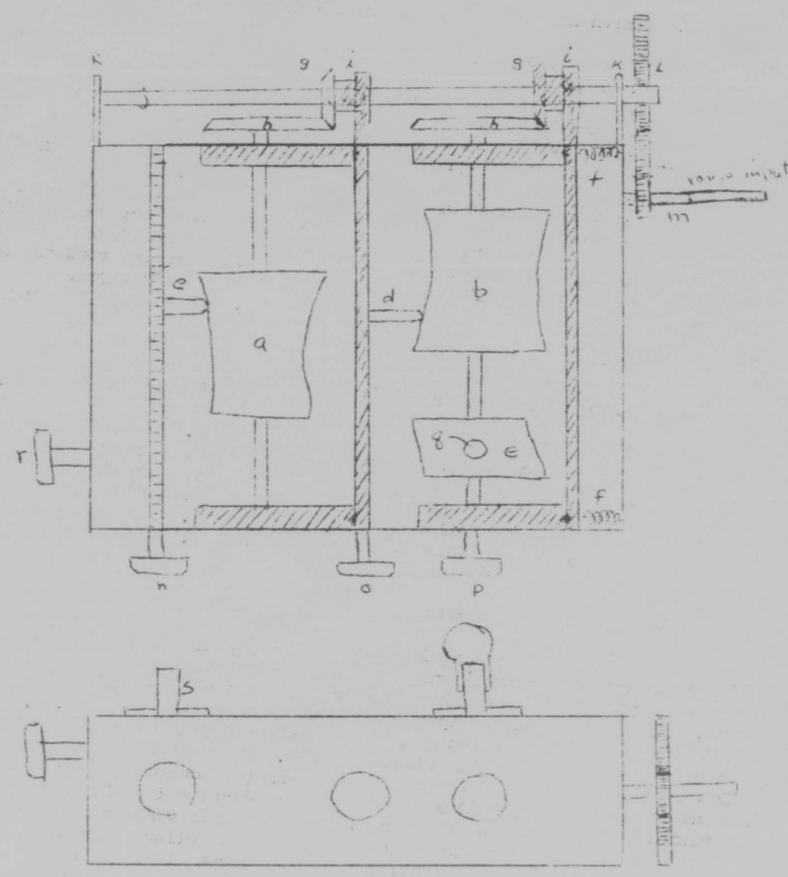


Fig. 2 Ballistics Parallax Computer



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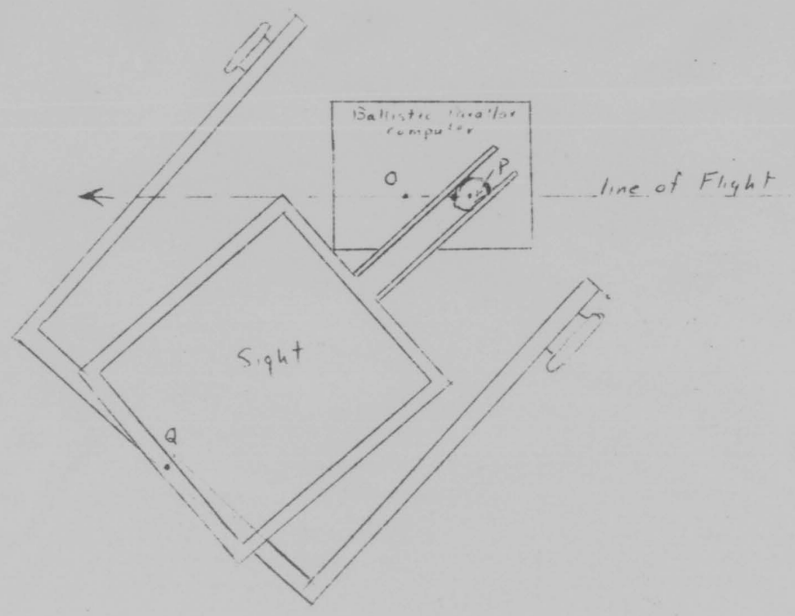


Fig 3 Top View Perlactal Sight

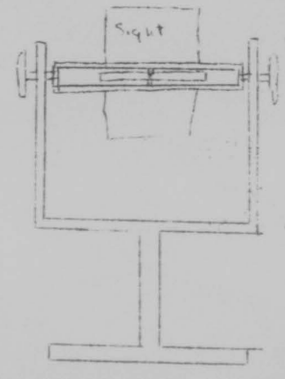


Fig 4 Side View Perlactal Sight



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5. Prediction Computer.

A. The formula for computing prediction incorporated in most sights is $\lambda = \omega t$ where $t$ = the present time of flight and $\omega$ is the present angular rate. This equation gives fairly accurate prediction for the case of rectilinear motion of the target and motion of the target in a circle around the bomber. It is slightly in error for other types of course especially pursuit curves. To compensate for the pursuit curve errors "fudge" factors are generally incorporated in the sight. Although these "fudge" factors serve to increase the expectancy of hitting aircraft attacking in most pursuit curves they make the sight a specialized device and thus somewhat inaccurate for other passes. The proposed computer essentially performs the same multiplication of time of flight by angular rate. The prediction is computed by means of the same gyroscopes and similar time of flight network as incorporated in the present computer except that the traverse gyro is changed to an azimuth gyro. By this arrangement the prediction comes out directly as shaft rotations proportional to the lead in azimuth increment and elevation increment. These shaft rotations are used to turn the differential selsyn or perhaps actual mechanical differentials which would alter the 1 and 31 speed selsyn generator positions directly by the lead angle.

Operation of Prediction Computer. If the sight is moved at an angular rate $\omega$ a precession torque develops which displaces the gyro axis thus closing a contact. The closing of this contact starts a motor which displaces the position of a potentiometer geared to the lead output shaft until the current in the erecting coil on the gyro is sufficient to counter-balance the precessional torque. When this occurs the gyro contact is opened and the motor ceases. The net displacement of the potentiometer then depends on $i_c$ (the current through the evedingcott demanded by gyro) and the resistance in the time of flight network which is in series with this coil. This description applies to both the azimuth and elevation components of the system.

B. Time of flight as a function of Range Altitude temperature, air speed and other factors: The time of flight of a projectile to a future range may be written as:

$$t = \overset{(a)}{\frac{D}{V_s}} + \overset{(b)}{\left(\frac{\nu\rho D}{V_s}\right)\frac{D}{V_s}} + \overset{(c)}{\kappa\Delta T\frac{D}{V_s}} + \overset{(d)}{\frac{\Delta V_s}{V_s}\frac{D}{V_s}}$$

$$+ \overset{(e)}{\left(\frac{\nu\rho D}{V_s}\right)^2\frac{D}{V_s}} + \overset{(f)}{\frac{3}{2}\left(\frac{\nu\rho D}{V_c}\right)\left(\frac{\omega_b}{V_s}\right)\frac{D}{V_c}\cos\theta} + \overset{(g)}{\frac{gD^2}{V_c^2}\left(1+\frac{a}{3}\frac{\nu\rho D}{V_s}\right)\cos\theta}$$

$$+ \overset{(h)}{\psi'\left(\frac{\omega_b}{V_c}\right)^2\frac{D}{V_s}\sin^2\theta} + \overset{(i)}{\frac{P}{V_o}\cos\theta}$$

(a) Main time of flight term.

(b) 1st Order correction for slow down.





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(c) Temperature correction term for muzzle velocity.

(d) Correction term for changes of muzzle velocity due to barrel wear or minor ammunition changes.

(e) 2nd order correction for slow down.

(f) 2nd order correction for variation in slow down as a function of the angle of the gun with line of flight.

(g) 2nd order correction for variation in slow down for different angles of the gun with the vertical.

(h) 2nd order correction for yaw drag where $\psi$ is a complicated function of altitude, airspeed, and range.

(i) Correction for the time to travel the parallax distance.
A host of higher order items are ignored.

C. Time of Flight Network. (See page 12)

D. Mechanical Input to Time of Flight Network:

The two precision resistances which form the most important component of the time of flight network have their rotating contact arm attached directly to range shaft. These resistances satisfy the equation.

$$R = \frac{D}{2V_s} - \frac{R_c + R_o}{2}$$

The main slow down correction resistance is geared to the altitude handset shaft and satisfies the equation $K_4 r_3 = \rho'$ where the relative air density is an assumed function of the altitude. The temperature correction for muzzle velocity is inserted by $r_4$ which is also attached to the altitude handset shaft. A temperature altitude function is assumed. The resistance satisfies the equation.

$$\frac{R_c}{r_4} = K \Delta T$$

Compensation for changes in muzzle velocity due to barrel wear or minor ammunition changes is made by rheostat which is adjusted by skilled mechanics prior to the mission.

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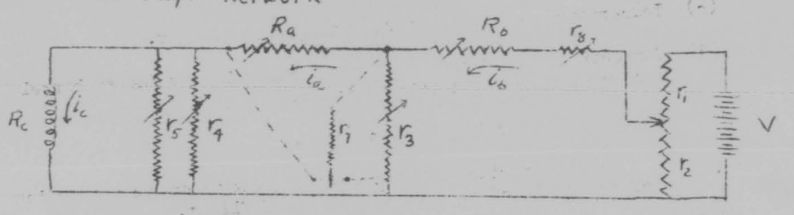
C. Time of Flight Network




Solution

$$\frac{r_2}{r_1+r_2}V = R_c i_c + R_a i_a + \left(R_b + r_8 + \frac{r_1 r_2}{r_1+r_2}\right) i_b$$

$$i_a = i_c\left(1 + \frac{R_c}{R_1} + \frac{R_c}{r_5}\right)$$

$$i_b = i_c\left(1 + \frac{R_c}{r_4} + \frac{R_c}{r_5}\right)\left[1 + \frac{R_a}{r_3} + \frac{1}{r_3}\left(\frac{1}{R_c} + \frac{1}{r_4} + \frac{1}{r_5}\right)^{-1}\right]$$

Conditions Let $R_a = R_b = R$

$$\frac{r_1 r_2}{r_1+r_2} + r_8 = R_s$$

$r_4 \gg R_c \quad r_5 \gg R_c \quad r_3 R \gg R_c^2 \quad R \gg R_b \quad R \gg R_s$

$$\therefore \frac{r_2}{r_1+r_2}V = i_c\left\{2R + R_c + R_s + \frac{r_3}{r_4} + \frac{2R_c R}{r_4} + \frac{2R_c R}{r_5} + \right.$$
$$\left. + \text{higher order terms}\right\}$$

Now let $2R + R_c + R_s = \frac{D}{V_s}$

$$\frac{1}{4r_3} = \nu\rho \qquad \frac{R_c}{r_4} = KbT \qquad \frac{R_c}{r_5} = \frac{\Delta V_s}{V_s}$$

$$\therefore \frac{r_2}{r_1+r_2}V = i_c\left\{\frac{D}{V_s} + \left(\frac{\nu\rho D}{V_s}\right)\frac{D}{V_s} + KbT\frac{D}{V_s} + \frac{\Delta V_s}{V_s}\frac{D}{V_s} + \right.$$
$$\left. \text{higher order terms}\right\}$$

but $i_c = \kappa\omega$

$$\therefore \lambda = \omega t$$



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Rheostat R8 is a compensating resistance geared to the lead output motor which serves to maintain the effective impedance of the voltage source constant.

The slow down term involving gun angle may be obtained from the elongation of the sight bar which is given by $\frac{\rho\rho}{V_s}\frac{\omega^2}{V_s}\cos\theta + \frac{1}{2}\frac{D}{V_s^2}\left(1+\frac{4}{3}\frac{\nu\rho D}{V_s}\right)\cos 2\theta + \frac{2}{3}\cos 3\theta$

Strangely enough not only would compensation be thus made for the added time it takes a bullet moving forward to reach a given distance from the bomber but also the added time required for a bullet to travel upward and, in addition, the extra time for the bullet to travel the parallax distance.

E. Lead expansion and contraction:

Lead expansion or contraction is desirable to correct for terms which arise when the lead is changing rapidly. With the smooth data made possible by radar ranging a rough correction for the change in lead which arises during the time of flight of the projectile may be made as follows:

A switch is attached to the shaft of the lead follow-up motor such that if the motion of the shaft is in one direction, one circuit is closed. If the motion of the shaft is in the opposite direction a second circuit is closed. A high resistance R6 with three taps is inserted in parallel with the erecting coil. When the lead is increasing this resistance is decreased $\Delta R$ by the closing of the motor connected switch. When the lead is decreasing this resistance is increased. Compensation for the normal value R6 of the high resistance is made directly in the precision resistors. The expansion and contraction of the lead is given approximately by

$$\Delta\lambda = \pm 2\frac{R_1 \Delta R}{R_6^2} i = \pm K t\omega = \pm K\lambda$$

Expansion given by $i\frac{R_3^2}{R_7} = K t\omega = t K\lambda$ may be obtained by shunting R3 by a resistance R7. Contraction given by $i\frac{R_3^2}{R_7} = K t\lambda$ may be obtained by shunting R3 by a resistance R7. No compensating resistances are required.

F. Use of Mechanical differentials:

Rather than rotate the differential selsyn by the lead angle it seems wise to use a mechanical differential to actually displace the 1 and 31 speed selsyn generators on the sight. This would render the sight and computer a complete unit whose output consists of the 12 wires 3 each for the 1 speed azimuth, 31 speed azimuth, 1 speed elevation and 31 speed elevation selsyns. These wires could be connected to the servo amplifier unit for any turret so that in effect any sight could control any turret. Control of any combination of turrets by any sight would also be possible. Thus not only is greater flexibility achieved but the number of cables strung through the ship is tremendously reduced. By means of small dials on the mechanical differential





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it would be possible to subject the computer to simple but thorough checks without additional equipment. This is an important deficiency of the present system.

6. Factors Influenced If Computer is Adopted.

A. Harmonization.

Short distance harmonization may be achieved by displacing the sight line from the gun line with the ballistics parallax unit or with the mechanical differentials. Accurate harmonization by either method by use of fidicial calibration points is possible. This method is the counterpart of present suggestions for short distance harmonization which would use a special differential selsyn unit to offset the sight line from the gun line. This suggestion is viewed as one of the most promising of proposed short distance methods. With the modified computer no additional equipment will be necessary.

B. Emergency Sighting:

Should the radar set fail, the gunner should immediately transfer the sight bar pivot to the Own Speed Sight pivot and adjust the Own speed vector for the true air speed (obtained from the navigator). The sight should be used against aircraft attacking in a pursuit curve by merely keeping the pip on the target. If the fighter deviates from a pursuit curve the gunners should lead along the line of the fighter fusilage to an extent depending on the fighter aspect angle.

C. Use of Computer with Frangible Bullets:

Over a limited region of space any projectile has a time of flight which satisfies the equation $t = aD + bD^2 + cD^3$

It can be shown that the principle of the present computer is thus applicable. For frangible bullets the ballistic parallax computer would require little modification. The parallax cam will remain the same; the windage cam may be used by merely recalibrating the follower dial. The vertical correction cam will probably require replacement. The time of flight network must be altered with rheostats having the correct resistance values. All other components of this system are retained.

D. The Use of Proposed Computer Without Radar:

The proposed sight may be used in conjunction with a stadiometric ranging device should radar ranging be unavailable at an early date. It appears that a range motor controlled by rheostat would be an improvement over the present ranging system. The computer will in all respects be identical with the proposed one with the exception that the range input will come from the drive motor instead of the radar set.

E. Use of Proposed Computer with Ring Sighting Station:

The Own speed sight developed by Captain H. Henderson for a Martin turret would form the basis for the ring sight version of the proposed computer.





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Again the length of the victor displaced along the line of flight would be determined by means of the ballistics parallax computer. All other details will remain the same as the computer for the pedestal sight. This vector sight could also form the basis for modification of the proposed computer for local turrets.

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## APPENDIX I

$t$ is the time of flight to future range.

$\omega$ is the angular tracking rate

$D$ is the future range (i.e. dist between gun and bullet).

$V_s$ is the standard muzzle velocity.

$\nu$ is the ballistic factor of dimension (Sec)-1 .206 M2
.22 M8

$\rho$ is the relative air density.

$w_B$ is the bomber true air speed.

$g$ is the gravity constant.

$z$ is the Zenith angle.

$\theta$ is the angle between line of flight of the bomber and line to target.

$P$ is the lateral parallax distance.

$\delta$ is the vertical parallax distance.

$w_{iB}$ is the bomber indicated air speed.

$\Delta T$ is the deviation of the temperature of the ammunition from standard.

$\Delta V_s$ is the deviation of the muzzle velocity at standard temperature from standard.

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## APPENDIX II

### Errors in Present R.C.T. System

It is assumed that the gunner is a part of the Remote Control Turret System and that the system is well maintained. The errors are divided into the following classes:

Class A. Gross errors which on the average exceed 20 mils.
Class B. Errors which average approximately 10 mils.
Class C. Errors which average approximately 5 mils.
Class D. Errors which average less than 5 mils.

The list presented is based on rough estimates from data obtained from the centers of B-29 Gunnery Information. It is probable that the position of several items is in error. In particular the extent of average harmonization shifts is uncertain and awaits the results of further studies at Alamagorda.

Class A
1. Inaccurate Target Framing

Class B
2. Inaccurate tracking
3. Delay of Range Follow-up Mechanism
4. Inaccurate Target Dimension Setting

Class C
5. Harmonization Shifts
6. Backlash used in smoothing
7. Delay in lead follow-up mechanism
8. Temperature muzzle velocity shifts
9. Muzzle velocity shifts due to barrel wear
10. Change from M2 to M8 ammunition
11. Curvature of the path of the target

Class D
12. Delay and errors in other follow-up mechanisms in computer
13. Plexiglass distortion
14. Vertical Parallax
15. Windage jump
16. Conversion and composition of lead (near zenith)
17. Initial harmonization
18. Yaw and Gravity drag
19. Change in ballistic constant of ammunition
20. A host of small factors ignored by theory and the computer mechanism

The use of a radar computer combination should reduce the Class A and Class B errors very considerably. All Class C errors, with the exception of the harmonization shifts, and several of the Class D errors appear amenable to reduction by a radar computer combination.



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## APPENDIX III

Windage Jump Compensation. To a good approximation, windage jump may be given by $20 \frac{v_w}{v_s} \sin\theta$ (in mils).

For the true air speeds of the B-29 an average figure may be taken as $4 \sin\theta$ (in mils). The deflection is clockwise (looking forward along the line of flight) perpendicular to the plane of action. If after leveling and harmonization all sights are tilted counter-clockwise by 4 mils, accurate compensation for windage jump will be made. Unless a radar computer is employed, however, it is doubtful whether this refinement will appreciably improve the firing effectiveness.

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## APPENDIX IV

## BIBLIOGRAPHY

Computers Models 20H1C1 and 20H1D1
for B-29 Airplane General Electric Manuel

A.F Memo 104.2M Ballistic Formulas

Research Bulletins
101 and 106 Research Division
Laredo Army Air Field

Submitted by:
Alex E. S. Green
Operations Analyst

APPROVED: Dr. R. L. Stearns, Chief
Operations Analysis Section
XX Air Force Headquarters



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SUBJECT: Report of the Pasadena Conference 23 Mar 45

TO: Asst. C/S, A-3 (OC&R) #1
Attention: Lt. Col. G. W. Hill, Jr. RGG/ma/72993

FROM: Twentieth Air Force, Operations Analysis Division
THRU: DC of S, Personnel and Administration

1. Enclosed is a copy of the Report of the Pasadena Conference on Defense of B-29 Formations.

2. This Conference was called for the purpose of integrating the conclusions of various groups which have been concerned with the problem of the defense of the B-29. The Conference members were directed to address their attention specifically to an evaluation of the Tactical Doctrine of Formation Defense developed at XX Bomber Command.

3. Since the Report was prepared primarily for the consideration of Overseas Commands, we intend to send copies to the XX and XXI Bomber Commands, asking for an expression of concurrence or non-concurrence with each recommendation contained therein. Before so doing, however, we would welcome a critical examination of the Report.

4. Accordingly, your comments on the substance, conclusions and recommendations in this report are requested.

5. It is planned to have Dr. Richard G. Gettell, Operations Analyst, this Headquarters, deliver the Report personally to General LeMay. Dr. Gettell is scheduled to leave Washington on 1 April. It is requested, therefore, that your comments be made available to him, in Room 4E168, before his departure.

Colonel P. M. WHITNEY,
DC of S, Personnel and Administration.

1 Encl (as above)

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SUBJECT: Report of the Pasadena Conference

TO: Twentieth Air Force, Operations Analysis Division 31 Mar 45

FROM: AC/AS, OCR Maj Browder/edn/72497 #2

1. The attached report of the Pasadena Conference on Defense of B-29 Formations has been thoroughly reviewed by this office and no criticism in either content or presentation is offered.

2. The conclusions contained in par. IIA are believed to be well-founded and completely substantiated by other information derived mainly from reports of combat personnel and representatives of continental agencies returned from visits to the theater. Especially true is conclusion IIA3 due to the complexity of the process of freely interchanging turrets.

3. The presentation of the conference evaluation of the present tactical doctrine followed by the detailed description of suggested minor improvements in specific instances, such as methods of stacking elements in the formation, areas of search and fire, and allocation of turrets is both lucid and logical. It is believed that the recommendations contained in par. II B and elaborated on throughout the report will prove most beneficial and well received by the overseas commanders.

4. Effort is now being made to devise the most efficient use of the nose sighting station in combating nose attacks and also to introduce support fire training into the flexible gunnery curriculum. The Central School for Flexible Gunnery is presently evaluating the various proposals for the use of the nose sighting station and the support fire rules when developed will be employed as soon as possible in the frangible bullet training program, utilizing a target airplane armored to withstand 360 degree fire.

1 Incl:
n/c

Bomb Br _____

OET Sec_____

AFRAE_____

GEORGE V. HILL, JR.
Lt. Colonel, Air Corps
Asst. Executive
AC/AS, Operation, Commitments
and Requirements

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23 March '45
RGJ/ma/72993

SUBJECT: Report of the Pasadena Conference

TO: Major General Curtis LeMay,
Commanding General,
Headquarters, XXI Bomber Command,
A.P.O. No. 234, c/o Postmaster,
San Francisco, California.

1. Dr. Richard G. Gettell, Deputy Chief, Operations Analysis Division, Twentieth Air Force, is carrying to you several copies of the Report of the Pasadena Conference on Defense of B-29 Formations.

2. We called this Conference in the hopes of integrating the various separate groups in this country which are working on problems of defending the B-29. The Conference members were requested to direct their attention specifically to an evaluation of the tactical doctrine of Formation Defense developed by you in the XX Bomber Command in the light of their special knowledge and of the combat experience recorded from your operations.

3. In my estimation, the Conference Report represents the most thorough and expert analysis yet made of the problem of formation defense of B-29s. The recommendations it contains appear to merit the fullest consideration by all Overseas Commands in the Twentieth Air Force.

4. Accordingly, it is requested that you institute a careful study of this Report, and reply by telecon your concurrence or non-concurrence with each of recommendations numbered B. 1-10 (on pages 3 and 4) and your views on the desirability of the adoption of recommendations C. 1-5 (on page 4), in Training Command and Training Air Forces.

5. Since Dr. Gettell was my representative at this Conference, he is prepared to answer any questions which may arise with respect to the contents of the Report.

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6. Additional copies of the Report are available at this Headquarters, if you desire them.

For the Commanding General, Army Air Forces:

LAURIS NORSTAD,
Brigadier General, U. S. Army,
Chief of Staff.

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2 April 1945

SUBJECT: Report of the Pasadena Conference on Defense of B-29 Formations.

TO: Commanding General, XXI Bomber Command, APO 234, c/o Postmaster, San Francisco, California

1. The Pasadena Conference was directed to address its attention to an evaluation of the Tactical Doctrine developed in the XX Bomber Command. This doctrine, which is built around a 12-plane stagger formation, was at that time expected to be introduced into the XXI Bomber Command coincident with the change in command. The Tactical Doctrine of the XXI Bomber Command dated 25 February, however, prescribes the use of an 11-plane formation.

2. The follwoing is designed to reorient the conclusions and recommendations of the Pasadena Conference from the twelve to the eleven-plane formation in order that they may be directly applicable to the XXI Bomber Command Tactical Doctrine.

a. With the single exception of Recommendation #3 for the restacking of the rear element of the formation, all recommendations listed on pages 3 and 4 of the original report are deemed applicable to the doctrine of the XXI Bomber Command. Specifically:

(1) Recommendation #1 - The adoption of the Rules for Turret Allocation listed in Section III C.

(a) This relates to general principles of defense, which are equally applicable to the 11 and 12-plane formations.

(2) Recommendation #2 - The adoption of the Rules for Briefing Areas of Search and Fire listed in Section III D.

(a) This likewise deals with general principles which are not restricted in their applicability to any particular formation.

(3) Recommendation #3 - The restacking of the rear element of the formation.

(a) This is withdrawn as regards the XXI Bomber Command as long as an 11-plane formation is the standard since it is only relevant to a formation

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which includes a rear element, If, however, a 12-plane stagger is ever contemplated, then consideration should be given to this.

(4) Recommendation #4 - The maintenance of a tight formation.

(a) This recommendation is equally valid for an eleven as for a twelve-plane formation. The sacrifice fo fire power, and the blocking of guns in a loosened formation described in Section IV E would occur in each type formation.

(5) Recommendation #5 - The application of Turret Allocation and Briefing Rules to insure adequate defense of formations of sub-standard numbers.

(a) Regardless of the standard formation used by a Command, circumstances can be expected to arise which will result in formations of sub-standard numbers.

(6) Recommendation #6 - The adoption of radius framing as described in Section VI B.

(7) Recommendation #7 - The adoption of the techniques of search proposed in Section VI C.

(8) Recommendation #8 - The adoption of the practice of firing at tail breakaways as described in Section VI D, if found practicable.

(9) Recommendation #9 - The indoctrination of gunners on the points discussed in Section VI E.

b. These recommendations all relate to gunnery techniques which are independent of the formation flown. Each, it is believed, would add to the defense of the XXI Bomber Command formations.

(10) Recommendation #10 - The expedition of attempts to improve the accuracy of fire against nose attacks.

(a) Gunners are now employing a make-shift technique, spinning the range wheel, in an effort to offset computer lag. This technique, and several alternative suggestions, are shortly to be tested at Eglin Field. The results will be forwarded when available.

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c. Recommendations C 1 through 5 relating to the training program are not affected by the difference between the 11 and 12-plane formations.

3. Your comments, with concurrence or non-concurrence, on each of the above recommendations are requested.

By Command of General ARNOLD:

W. I. FISHER
Colonel, Air Corps
Deputy Chief of Staff

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HEADQUARTERS XXI BOMBER COMMAND
Office of the Commanding General
APO 234, c/o Postmaster
San Francisco, California

AITAC 319.1

SUBJECT: Report on the Summary of Conclusions and Recommendations in the Report of the Pasadena Conference on Defense of B-29 Formation

TO: Commanding General
Twentieth Air Force
Washington 25, D. C.

1. Upon receipt of report of the Pasadena Conference on Defense of B-29 formations, a committee met at the XXI Bomber Command Headquarters to discuss these recommendations as they applied to the formation flown and gunnery program in effect in this command. The following members composed this committee:

| | | |
|---|---|---|
| Doctor Gettell | - | Operations Analysis |
| Major Schonlau | - | XXI Bomber Command Plans and Tactics Section |
| Major McNeely | - | XXI Bomber Command Gunnery Officer |
| Major Anthony | - | XXI Bomber Command Gunnery Officer |
| Mr Nicholson | - | XXI Bomber Command Operations Analysis |
| Major Landry | - | 313th Wing Gunnery Officer |
| Capt Dorfman | - | 73d Wing Gunnery Officer |
| Capt Elliot | - | 314th Wing Gunnery Officer |
| Capt Redler | - | 58th Wing Gunnery Officer |

2. The principle conclusion of the Pasadena Conference fclows:

a. The combat experience bears out the test data and theoretical conclusions that B-29 formations are most vulnerable to fighter attacks which originate from nose level or nose high areas. The command concurs in so far as their statement refers to past experience. Prefer, however, to separate the problem into two parts:

(1) A B-29 is at the greatest defensive disadvantage when attacked from the nose.

(2) Most Japanese tactics show preference for nose attacks, but our most recent tactics involving lower altitudes and use of fighter escort may have forced the enemy to attack more frequently from the beam, tail or nose low.

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b. Massed defense against enemy attacks from a particular direction by free exchange of turrets offers an attractive possibility when crew coordination is well advanced, but it is believed this would lead to chaotic confusion if attempted at present. In general, the undersirability of indiscriminate exchange of turrets is realized. However, at present, turret exchange of the lower aft turret between blister gunners on attacks which develop from alternate sides or which cross over, also exchange of upper forward turret between ring gunner and bombardier when several attacks develop from the same direction and lower forward from bombardier to blister gunners for lead aircraft during bombs away is favored.

c. In view of recent combat experience it is believed that certain particular improvements could be made to meet the current tactical situation. This command concurs with this and is of the opinion that constant improvement in tactical doctrines is needed to meet current tactical situations.

3. Conference recommendations for the consideration of overseas commanders:

a. The adoption of the following rules for turret allocation:

(1) Wing ship or element - one each with ring gunner directed to the side or rear and outside blister gunner controlling the lower aft turret.

(2) Center ship or element - hi man with ring gunner directed forward.

(3) Rear ship or element - stacked low - hi man with ring gunner directed to rear.

(4) Rear ship or element - stacked high - one each wing ring gunner directed forward, blister gunner toward the rear.

b. It is agreed in the need for simple principles known to co-pilot to determine turret allocation and primary defensive responsibility. Believe, however, the rules should be simplified as follows:

(1) Basic turret allocation should be hi man. Permissible turret exchanges would be upper forward turret between ring gunner and bombardier, lower aft between blister gunners. On the bomb run, the allocation should be nose out for lead and deputy lead aircraft.

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AITAC 319.1 Subj: Report on the Summary of Conclusions and Recommendations in the Report of the Pasadena Conference on Defense of B-29 Formation

Whatever the number of aircraft in a formation the upper gunner should give the following primary protection:

(2) Forward: For all aircraft on the outside of the formation or inside of the formation if stacked high.

(3) Aft: All aircraft on the inside of the formation if they are stacked low.

(4) Blister gunners should direct their fire primarily to the outside of the formation.

c. The areas of search and fire advocated by the conference are agreed upon by this command:

(1) Nose gunners normally search and fire from 10 - 2 o'clock.

(2) Ring gunners search and fire over a 180° sector.

(3) Blister gunners search and fire over entire area, in which they are visible, their maximum sector being 150°.

(4) For areas of search and fire forward the azimuth limit of the area will be set at least one clock angle (30°) ahead of the friendly ships. When an area of search and fire is aft the azimuth limit of the area will be set up at least half clock angle (15°) astern the friendly ships.

d. The restacking of the rear element of the formation up instead of down is not pertinent to the eleven ship formation as flown by this command. The only possible reference this could have would be in restacking the fourth ship of the low element high instead of low.

e. The maintenance in combat of the tightest formation possible to fly to avoid the sacrifice of formations fire power is advocated by the conference. This is agreed with, if the desire is to maximize gunnery defenses.

f. For formations of sub standard numbers instead of a briefed turret allocation and rules of search and fire for each number from three through eleven ships the command believes that certain general rules should be given. These rules are the same as given in 2a.

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AITAC 319.1 Subj: Report on the Summary of Conclusions and Recommendations in the Report of the Pasadena Conference on Defense of B-29 Formation

g. The adoption of radius framing was advocated by the conference and agreed upon by the command. It was felt that this was the most important contribution of the conference.

h. The command concurs with the conference in the technique of search - namely:

(1) Carry the guns in each turret pointed as close to 12 o'clock as the area of search and fire is briefed to cover.

(2) Concentrate the search primarily in the area from which the fighters must appear.

(3) Maintain the present technique of scanning systematically searching various sectors of the sky. Stop at each sector long enough to permit the eyes to focus.

i. The adoption of the practice of firing at tail breakaways as proposed by the conference is concurred upon by the command. However, it is felt that the intercom reporting procedure whereby attack is called out by any crew member who sees it and not just the co-pilot is desirable. The co-pilot has other duties to perform while on the bombing run. Also with the increased number of tail attacks being received with lower altitudes, the training necessary, and the minimal time the enemy airplane is in range greatly limits the possiblities that htis offers. Test of feasibility of training tail gunners to coordinate his fire with reports of attacks are desired.

j. Teaching gunners when, where, and how to fire is desired by the command as advocated by the conference. Gunners should be well acquainted with the capabilities and limitations of their equipment. However, the bomber command believes that the value of deterrent fire is demonstrated in this theater. Gunners should fire at any enemy target within range and not withhold fire in excess of 600 yards as advocated by the conference. Determination of ranges to open fire should be left to the briefing officer.

k. The command and conference concur in the necessity of expedition of all attempts to solve the problem of improving the accuracy of fire against nose attacks. In addition, wish to express disapproval of proposed installation of press-bang computer since believe it inadequate against nose attacks.

4. To provide B-29 gunners capable of most effectively defending the formations which will be flown in combat the conference recommends

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AITAC 319.1 Subj: Report on the Summary of Conclusions and Recommendations in the Report of the Pasadena Conference on Defense of B-29 Formation

for consideration of Training Command and Training Air Forces:

a. Crew coordination training.

b. Formation gunnery training.

c. Establishing school for training of qualified instructors on B-29 gunnery.

d. Emphasis on doctrine of support fire. The command concurs but makes the follwoing strong reservations:

(1) Crew coordination training for formation defense should not under any circumstances be substituted for fundamental training in weapons, aircraft recognition, practice in the use of the B-29 equipment in the air as well as on the ground.

(2) Crew coordination training should consist almost entirely of practice in transferring controls, with emphasis on necessary precautions, while flying in formations and not in formal drill in classrooms on the ground.

(3) It would be impracticable and undesirable to attempt to impose the suggested turret assignment nomenclature on present combat crew.

(4) If new crews were trained in the proposed turret assignment nomenclature it is doubtful that the nomenclature would be used in combat.

(5) We disagree with the philosophy of having a single controller calling exchanges. We strongly favor the system now in use in the XXI Bomber Command in which exchanges are effected by mutual agreement among the crew members involved. To accomplish an exchange, we suggest that the gunner who wants a turret merely identify himself by the use of a phrase "Nose wants .....", "Right wants .....", "Left wants .....", Ring wants .....", followed by the name, or an agreed upon number of the turret he wants. The reply to this may be simply "Take it", "Roger", or "No". When a gunner wishes to relinquish a turret which he cannot

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automatically give to another gunner, he should similarly identify himself and the turret he is giving up. The gunner who takes it should identify himself by a statement such as "Left has it". It must be expected that individual crews will vary the language used in effecting exchanges.

(6) We strongly favor as much simulated combat, preferably with gun cameras, as possible for crews prior to their being sent to the theater.

CURTIS E. LeMAY
Major General, USA
Commanding

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Subj: Test Flight of B-29. 3 May 45.

CAF-353 (3 May 45) Flying 1st Ind A-3
HEADQUARTERS CONTINENTAL AIR FORCES, Bolling Field, D.C.,

TO: Commanding General, Army Air Forces, Washington 25, D. C.
Attention: Assistant Chief of Air Staff.

1. With reference to the three recommendations of the basic message, it is believed that further investigation of the effectiveness of fire upon breakaway nose attacks should be conducted. There are several factors which may indicate such fire to be undesirable.

a. The solution time required by the computer.

b. The dispersion at long range due to the time of bullet flight.

c. Fire damage to our own formation.

2. Advice is requested concerning research or training which this organization will be required to conduct on this problem.

FOR THE COMMANDING GENERAL:

D. S. HUBER
Major, AC
Actg Asst Adj Gen

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3 May 1945

EL 353

HQ TWO AF O&T T&O EL

COLO SPGS COLO

THRU: CG CAF CAMP SPRINGS AAFLD

WASH D C

TO: CG 20TH AF WASH D C

ATTN: DR GRITTAL

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1. PER YOUR REQUEST, THE FOLLOWING IS A BRIEF OF TEST FLIGHT MADE TO DETERMINE THE PRACTICABILITY OF B-29 TAIL GUNNERS FIRING AT THE BREAK-AWAY OF FRONTAL FIGHTER ATTACKS:

A. TEST WAS FLOWN BY B-29 AT A TAS OF 255 M/H AT 9000 FEET ALTITUDE. FIGHTER ATTACKS WERE MADE AT APPROXIMATELY TAS OF 270 M/H. EACH FIGHTER MADE 14 ATTACKS. THE ATTACKS VARIED IN AZIMUTH FROM 10:30 O'CLOCK TO 1:30 O'CLOCK AND IN ELEVATION FROM 10° BELOW TO 20° ABOVE THE HORIZON. THE MAJORITY OF THE FIGHTER ATTACKS BROKE AWAY WITHIN 200 YARDS OF THE B-29. A/N GUN CAMERAS WERE USED TO FILM ALL ATTACKS AND BREAKAWAYS VISIBLE TO THE GUNNERS.

2. OBSERVATIONS MADE DURING THIS TEST RELATIVE TO FRONTAL ATTACKS ARE AS FOLLOWS:

A. FRONTAL FIGHTER ATTACK BREAKING AWAY AT RANGES GREATER THAN APPROXIMATELY 400 YARDS ARE ABLE TO AVOID THE CONE OF FIRE OF THE TAIL TURRET.

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B. THE TAIL GUNNER MUST BE QUICKLY AND CLEARLY BRIEFED ON THE PROBABLE LOCATION OF THE FIGHTER BREAKAWAY, PREFERABLY BY THE PILOT WHO HAS A CLEAR VIEW OF THE ATTACK. THE BOMBARDIER IS TOO BUSY WITH HIS OWN GUNNERY PROBLEM TO CALL THE BREAKAWAY TO THE TAIL GUNNER.

C. IT APPEARED POSSIBLE FOR THE BLISTER GUNNERS TO FIRE AT THE BREAKAWAY OF FRONTAL ATTACKS, ESPECIALLY THOSE ATTACKS THAT BREAKAWAY OUT OF THE CONE OF FIRE OF THE TAIL TURRET.

3. INTERROGATION OF THE BOMBARDIER AND TAIL GUNNER REVEALED THE FOLLWOING:

A. IT IS DIFFICULT FOR THE BOMBARDIER TO JUDGE THE DIRECTION OF A BREAKAWAY WHILE OPERATING THE NOSE PEDESTAL SIGHT.

B. IF THE FRONTAL ATTACKS ARE CALLED ACCURATELY OVER THE INTERPHONE AND IF THE ATTACKS ORIGINATE OUTSIDE THE AREA BETWEEN 1100 AND 1300 O'CLOCK IT IS POSSIBLE FOR THE TAIL GUNNER TO LOOK OVER HIS SHOULDER AND SEE THE ATTACK, THEREBY ENABLING HIM TO GET "ON TARGET" DURING THE BREAKAWAY WITHIN 350 YARDS RANGE.

4. ANALYSIS OF THE GUN CAMERA FILM TAKEN BY THE TAIL GUNNER REVEALED THE FOLLOWING:

A. 28 FIGHTER ATTACKS WERE FLOWN. 17 ENTERED THE CONE OF FIRE OF THE TAIL GUNNER.

B. ALL ATTACKS ENTERING THE TAIL GUNNER'S CONE OF FIRE WERE PHOTOGRAPHED.

C. THE AVERAGE RANGE AT WHICH THE TAIL GUNNER WAS "ON TARGET" DURING THE BREAKAWAY WAS 400 YARDS.

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D. THE AVERAGE LENGTH OF BURST POSSIBLE FROM TIME THE TAIL GUNNER WAS "ON TARGET" UNTIL THE FIGHTER REACHED 900 YARDS WAS 1.8 SECONDS OR APPROXIMATELY 22 ROUNDS PER GUN.

5. CONCLUSIONS:

A. FRONTAL FIGHTER ATTACKS BREAKING AWAY WITHIN THE CONE OF FIRE OF THE TAIL GUNNER MAY BE FIRED ON EFFECTIVELY BY THE TAIL GUNNER.

B. THE TAIL GUNNER MUST KNOW THE APPROXIMATE POSITION IN WHICH THE FIGHTER BREAKAWAY WILL ENTER HIS CONE OF FIRE TO DELIVER EFFECTIVE FIRE.

C. THERE MUST BE A HIGH DEGREE OF COORDINATION BETWEEN THE TAIL GUNNER AND A CREW MEMBER WHO CAN SEE THE ENTIRE FRONTAL ATTACK.

6. RECOMMENDATIONS:

A. THAT AN SOP FOR PILOT-TAIL GUNNER COORDINATION BE ESTABLISHED THAT WILL INFORM THE TAIL GUNNER OF THE PROBABLE POSITION IN WHICH THE BREAKAWAY OF EACH FRONTAL FIGHTER ATTACK WILL ENTER THE TAIL CONE OF FIRE.

B. THAT THE PRACTICABILITY OF BLISTER GUNNING FIRING AT BREAKAWAYS OF FRONTAL ATTACKS ALSO BE INVESTIGATED.

C. THAT AAF BOARD INVESTIGATE THE EFFECTIVENESS OF B-29 CALIBER .50 MACHINE GUN FIRE ON ENEMY FIGHTERS DURING THE BREAKAWAY PHASE OF FRONTAL FIGHTER ATTACKS.

7. ACTION IS BEING TAKEN BY THIS HEADQUARTERS TO CARRY OUT ABOVE RECOMMENDATIONS. END CG T'O AF WILLIAMS

OFFICIAL

R.E. ALLEN
Colonel, GSC
Deputy Chief of Staff
3 Operations & Training

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Headquarters
ARMY AIR FORCES
CENTRAL SCHOOL FOR FLEXIBLE GUNNERY
Laredo Army Air Field

B-59: jdd

Laredo, Texas

8 June 1945

Dr. Richard G. Gettell
Headquarters Army Air Forces
Room 4E168, Pentagon Building
Washington, D. C.

Dear Dick:

Inclosed is a copy of the manuscript on tactical use of B-29 equipment. Copies have also been transmitted to Major Keys and Bragarnick.

This manuscript is for the mimeographed edition only. It still needs sharper organization and less wordy writing for inclusion in GIF.

Your comments will be appreciated.

Very truly yours

WALTER R. VERNSTROM
1st Lt., Air Corps
Project Officer
CSFG Publications Unit

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JUNE, 1945

# GUNNERY IN THE B-29:
# THE TACTICAL USE OF EQUIPMENT

(A preliminary release of material that will shortly
appear as a new addition to the B-29 section
of the Gunner's Information File)

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TACTICAL DOCTRINE BY
B-29 COMBAT COMMANDS AND
TRAINING AIR FORCES

PREPARED BY
CENTRAL SCHOOL FOR FLEXIBLE GUNNERY
LAREDO, TEXAS

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SECTION 1

GUNNERY IN THE B-29:

THE TACTICAL USE OF EQUIPMENT

In the B-29 you are not only part of a close-knit team of gunners in your own bomber, but almost always part of a big team of bombers flying with you. Sometimes your bomber may raid alone. Other times it may fly alone to some designated point to join other bombers on the bombing run. But generally your bomber will fly with other bombers in a formation.

You can never afford to forget this. You are never the only gunner in the sky. There are other gunners helping you to defend your own bomber and your formation. In turn, you've got to help them defend their bombers. This mutual confidence and teamwork is essential for the B-29 to complete its great strategic mission.

The How and Why of Formations

There's nothing hard to understand about B-29 formations. They are simply mutually protective combinations for plastering the enemy. They come in many shapes and sizes to do different kinds of jobs and meet different kinds of conditions. Whatever their size or shape, they have a single major purpose -- to deliver the heaviest possible concentration of bombs on enemy targets.

In building a bomber formation, however, three separate factors have to be taken into account. The first is flyability -- the formation must be so spaced out and stacked the pilots can fly it with ease and safety. The second is bombing effectiveness -- the formation must be so well-balanced that its bombs fall closely together on a target. The third is defensibility -- the formation must be so arranged that its guns cover it on all sides and gunners can get as many turrets firing as possible on the same target wherever needed.

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No formation ideally meets all three conditions. The best formation for concentrated bombing might be a big one, tightly grouped, but it would be easy to hit and hard to fly. The best formation for defense might be one stacked straight up in the air, but it would be no good for bombing. Every formation is a compromise. Therefore, you will find yourself flying with bombers ranged all around you, level, above, and below. To protect all sides of your formation, to hit enemy fighters and not hit your own bombers, takes teamwork. Every gunner has to have a definite job in the formation and protect a definite area of sky.

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Your Defensive Equipment

Defense is your department, and in the B-29 you have the most flexible and powerful gunnery defense weapon in the air

The B-29 Remote Control Turret System allows you to transfer turrets and concentrate your fire in the flick of an eye. A single bomber has 36 different, possible gunner-turret combinations. A formation of eleven bombers can wield a total of at least 110 machine guns in an endless pattern of fire.

The B-29 computer allows you to sight and fire effectively on anything within range. The target does not have to be flying a pursuit curve attack on your own bomber. You can handle both defense fire, directed at a fighter attacking your own bomber, and support fire, directed at any fighter within range not attacking you. It makes no difference. You can shoot down anything within range.

The rest of this manual will show you how to get the most out of this equipment -- the basic tactics of B-29 defense. First, you must know what part of the team's equipment is yours, and how controls are shifted to meet various combat situations. Then you have to know where to look for attacks and how to report them, so that your vision becomes part of the formation's overall vision.





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Finally, you have to know how to search and fire, and how your role in the big team changes to fit different formations.

In training you will be drilled in these procedures by the numbers, on formal commands. By the time you get to combat they should be instinctive -- you will be expected to carry them out automatically. Maximum all-around protection, a minimum of self-inflected damage, and concentration of fire power wherever needed are the three big objectives. Alert gunners, working together, can bring them to a peak in any B-29 formation.

SECTION 2

THE BASIC TURRET ALLOCATIONS

B-29 defense would be a complicated business if you had to keep all of the different gunner-turret combinations in mind. You don't have to. Combat experience has shown that all of these combinations boil down to two basic allocations of turrets to gunners -- one for formation defense, the other for defense of bombers flying alone. These are the ones that have proven best in battle. Three or four variations of these basic allocations handle most combat situations.

Both basic allocations have a left or right phase, depending upon which side gunner has control of the Lower Aft Turret. If the right side gunner has the Lower Aft Turret, it is a right phase. If the left side gunner has control of this turret, it is a left phase. Fire power is greater on that side of the bomber that controls the Lower Aft Turret.

The Basic Allocation for Formations

Under normal conditions, on take-off, each gunner in a B-29 formation takes his position and turns on his switches to get this set-up:

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The top gunner controls both the Upper Forward and Upper Aft Turrets.

The nose gunner controls the Lower Forward Turret.

One side gunner controls the Lower Aft Turret.

The tail gunner controls the Tail Mount.

This is the basic turret allocation for formations -- see Figure 1 -- and it is called HI-MAN, Left or Right.

Variations on this allocation to meet changing conditions run as follows:

1. The nose gunner may take over the Upper Forward Turret from the top gunner to meet heavy or successive high nose attacks. This shifted allocation is called PRIMARY, Left or Right.
2. The nose gunner in the lead or deputy lead plane of a formation during a bombing run releases his Lower Forward Turret to the side gunner not controlling the Lower Aft Turret in order to free himself for his bombing duties. This is called NOSE OUT, Left or Right.
3. The side gunner not controlling the Lower Aft Turret takes over the Tail Mount from the tail gunner in case the tail gunner or his sight is disabled. This emergency allocation is called TAIL UP.

The Basic Allocation for Bombers Flying Alone

Bombers fly alone on either night or daytime missions. On night missions, only the tail gunner with his radar detection equipment is effective; the rest of the gunners are either left at home or stand by on the chance that visual contact is made with the enemy. On normal daytime missions by a single B-29, the gunners take their positions and each controls one turret:

The nose gunner controls the Upper Forward Turret.

The top gunner controls the Upper Aft Turret.

One side gunner controls the Lower Forward Turret.



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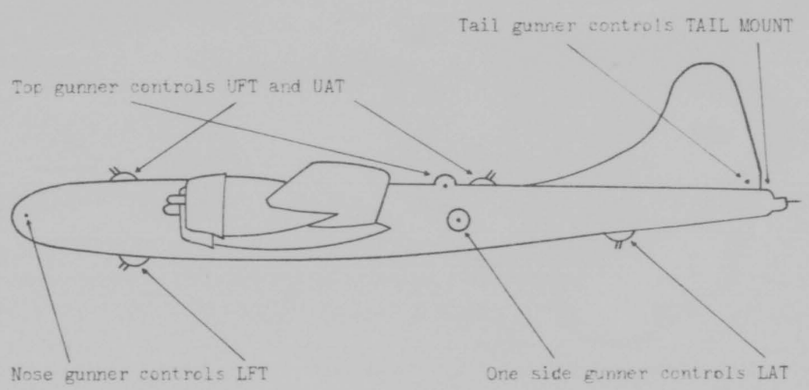
## BASIC ALLOCATIONS OF TURRETS TO GUNNERS

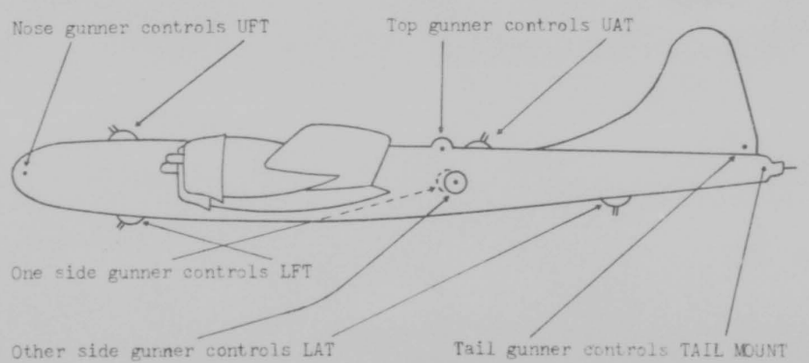
HI - MAN

Figure 1




ONE EACH

Figure 2



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The other side gunner controls the Lower Aft Turret.

The tail gunner controls the Tail Mount.

This is the basic allocation for a single bomber flying alone by day -- see Figure 2 -- and it is called ONE EACH, Left or Right.

Variations on this allocation for single bombers go like this:

1. One side gunner takes over the other lower turret from the other side gunner to meet concentrated attacks from one side, level or below. This allocation is called GANG LOW, Left or Right.
2. The nose gunner releases his Upper Forward Turret on the bombing run to the top gunner to free himself for his bombing duties. This allocation is called NOSE OUT, Left or Right. The same shift is used to enable the top gunner to concentrate fire from two turrets on high attacks in the rear, so long as the nose is not being attacked at the same time.
3. The nose gunner may give up his Upper Forward Turret to the top gunner, and one side gunner give up his lower turret to the other side gunner, to meet mass attacks from one side, high and low. This double switch allocation is called BROADSIDE, Left or Right.
4. The side gunner not controlling the Lower Aft Turret takes over the Tail Mount from the tail gunner in case the tail gunner or his sight is disabled. This is called TAIL UP.

With this set of basic turret allocations you are ready for almost every combat situation. You may on occasion have to figure out something new to meet an unusual situation. But if you can handle these basic allocations, you can handle any emergency.

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THE DEFENSE OF FORMATIONS

To understand your job in a B-29 formation, you have to know what you're up against. Combat experience in the Pacific has shown that attacks from some areas around a B-29 formation are much more dangerous than attacks from other areas. A few areas are almost tactically dead or hard to attack from.

The most dangerous of all attacks are from the nose, from about 11 to 1 o'clock. Most Jap attacks have been nose attacks, usually high. From this direction your bomber's nose and four engines are big and vulnerable targets, while the short duration of nose attacks makes the fast-moving Jap hard to hit. The next most dangerous area of attack is off your tail, from about 5 to 7 o'clock, where many attacks wind up. Though the enemy can hit you from here, you have a much better chance of hitting him. Tail attacks are almost sitting duck shots for you.

Dead abeam is the poorest of all attack areas, both for enemy fighters and for you. It's hard for you to hit them because of the large deflections involved, and besides, you have to be particularly careful on the beam not to hit some other bomber in your formation. But it's also hard for them to hit you. Fighters have to keep humping to overtake you on the beam. They mush badly, pilots get the nose of their own plane in the way of their vision, and generally they have poor shooting conditions.

Forward, therefore, is the most dangerous area. Most bomber formations and the basic turret allocations are designed to mass fire power forward. And your most effective fire on attacking fighters is forward and aft, with the emphasis always forward, because that's where most of your targets will be.

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The Areas of Search and Fire

To meet this combat situation, and provide all-around protection, the sky around your formation is divided up into areas. Each gunner, in addition to controlling a specific turret combination, must also patrol a specific and limited area of the sky. The area of sky he searches is also the area in which he fires -- with the single exception of the tail gunner, who fires in a smaller area than he searches.

If everyone searched and fired as he pleased, everything would be plainly fouled up. There would be no assurance that the most dangerous areas of attack were getting enough attention. Ten gunners might be searching a single area, while another area went unnoticed. Gunners, who cannot search and fire effectively throughout their full field of vision anyway, would be wasting time on areas where they cannot fire effectively. Without gunner coordination the whole RCT System would lose most of its advantages.

Therefore, you must know your area of search and fire -- and stick to it. Each gunner must be sure that every other gunner is minding his own area, otherwise there will be fatal blind spots. The best place to start this mutual confidence is right in your own station. If every gunner concentrates on his appointed area, the sky around a formation will be fully covered and every fighter within range of its gun will be taken care of.

The general areas of search and fire assigned to each gunner are listed below and diagrammed in Figures 3 to 6. They are in general terms because the areas will have to be shifted slightly or cut down slightly to fit different formations. These are the basic areas, however, that will later be modified to fit particular situations.

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| | Searches & Fires in Azimuth | In Elevation |
|---|---|---|
| NOSE GUNNER | Generally forward (10 to 2 o'clock) where possible: 4 hours on the clock (120°); if bomber is stacked high behind other bomber, cannot fire unless he has UFT. | 60°, scaling up or down, depending on whether he has UFT or LFT. |
| TOP GUNNER | Generally forward (9 to 3 o'clock) where possible; 6 hours on the clock (180°): if bomber is stacked low behind other bomber, swings about and searches aft. | 60°, up from horizontal. |
| SIDE GUNNERS | One searches and fires to the outside of the formation, the other searches to the inside (1 to 5 o'clock right, 6 to 11 left); 5 hours on the clock (150°); restricted as necessary to avoid hitting other B-29's. | 60°, down from horizontal. |
| TAIL GUNNER | Searches aft wherever he can see (3 to 9 o'clock); 6 hours on the clock (180°); but fires only 2 hours on the clock (5 to 7, or 60°) due to limit stops; restricted as necessary to avoid hitting other B-29's. | 90°, divided evenly above and below horizontal and restricted high or low to avoid hitting other B-29's. |

These basic areas are restricted or cut down to avoid hitting other bombers according to a set rule, which is: Every area of search and fire must stop one full clock angle (30°) in azimuth away from any other bomber in the formation.

This rule for defining areas, slightly modified, also serves as a safety rule in firing, if you ever forget the limits of your search and fire area in the heat of battle.

You must withhold fire, in azimuth:

1 hour clock angle (30°) away from another B-29 when tracking into it.

½ hour clock angle (15°) from another B-29 when tracking away from it.

These are important safety precautions. They allow a safety margin for your computer leads and for parallax, when your guns may be pointing far ahead or lagging far behind the point at which you are aiming.



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GENERAL AREAS OF SEARCH AND FIRE

NOSE GUNNER

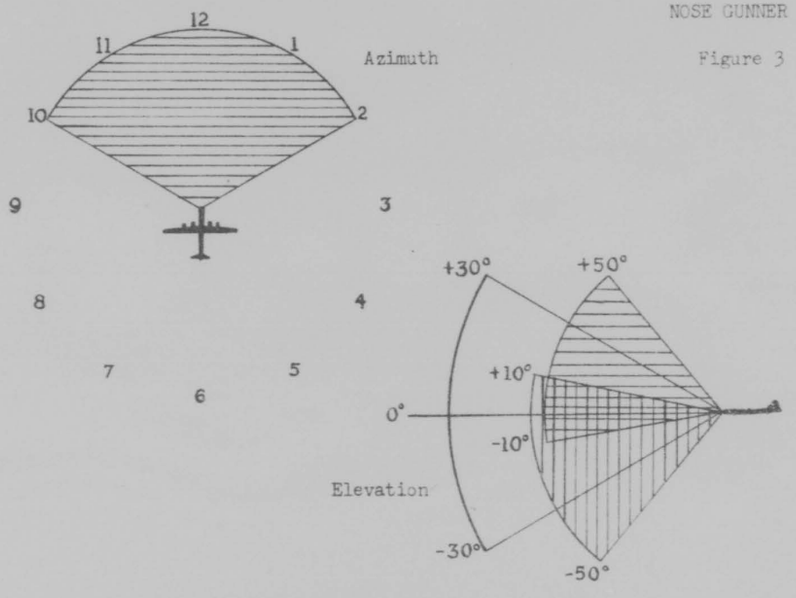


Figure 3

TOP GUNNER

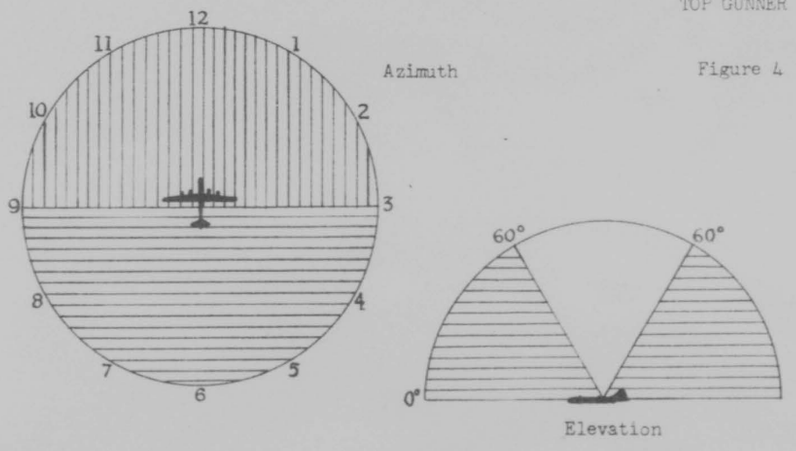


Figure 4

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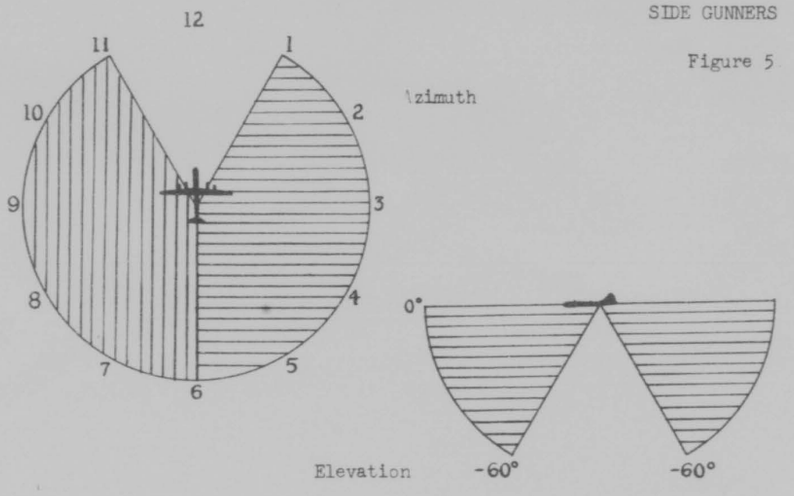
GENERAL AREAS OF SEARCH AND FIRE

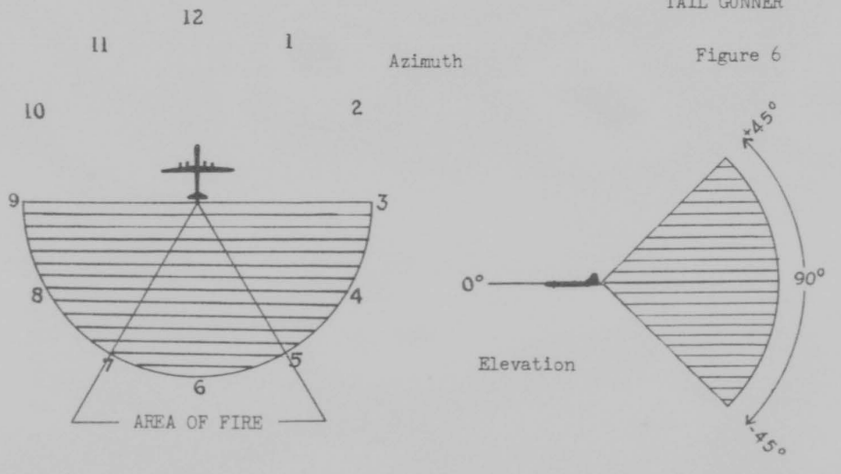
SIDE GUNNERS

Figure 5




TAIL GUNNER

Figure 6

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How to Search and Fire

Know your area of search and fire, then follow these rules and procedures.

SEARCH: The rules for searching aren't many, but chief among them is: You've got to look with the expectation of seeing something. The man who doesn't expect to see something -- doesn't. Focus your eyes at the outer range of your area, and look to see. Don't look merely to be looking. Keep your attention focused and stay alert. A methodical system for hunting the sky may help:

1. Divide your area of the sky in your own mind into small zones.
2. Focus on the zone farthest forward, and don't let your eyes leave it until they have done a thorough job of searching in that zone.
3. Then shift to the next zone and do the same job.
4. Stick to your own area.
5. Always search the forward part of your area more frequently and carefully than any other. That's where most attacks appear to start in relative motion, and that's where your hottest attacks come from. Search more often in the forward zones, rather than linger longer in them.
6. Always keep your guns pointing forward at stand-by -- ready for the draw, to pick up targets swiftly and track them from front to rear.

REPORT! As soon as you see any aircraft, get on interphone. The coordination necessary to meet attacks requires that your fellow gunners know what to expect. Report both enemy and friendly planes. Use the standard clock system, high, low, and level, in locating aircraft. (Level is anything about on a level with your horizon, within plus or minus 10°; high is above that; low is below it.) Talk clearly and concisely, with careful enunciation and firm volume. Don't shout. Use only the following standard words and phrases -- no others --



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and clearly pause between items, as indicated. Repeat each message once.

1. Threating. As soon as you see aircraft threatening -- maneuvering, overtaking, climbin, in position, turning in, etc. -- report them like this.

   number and type (pause) clock and elevation position (pause) if enemy, what they are doing

   FIFTEEN TWIN-ENGINE FIGHTERS (pause) ONE O'CLOCK LOW (repeat)
   TWENTY FIGHTERS, FRIENDLY (pause) THREE O'CLOCK LEVEL (repeat)
   ELEVEN TOJOS (pause) EIGHT O'CLOCK HIGH (pause) OVERTAKING (repeat)

2. Guns Bearing. As soon as a target is plainly attacking, guns bearing, report briefly, like this.

   attack (pause) clock and elevation position

   ATTACK (pause) ONE O'CLOCK HIGH (repeat)
   ATTACK (pause) FOUR O'CLOCK LEVEL (repeat)

3. Breakaway. In the breakaway phase of an attack, gunners other than those firing on the attack -- particularly tail and side gunners on nose attacks that pass over or under the bomber to complete their breakaway -- may have a perfect shot at the target providing they are forewarned. On breakaways, report to the gunner concerned like this.

   attack (pause) clock and elevation position (pause) how breaking away

   ATTACK (pause) TWELVE O'CLOCK LEVEL (pause) BREAKING AWAY UNDER (repeat)
   ATTACK (pause) ONE O'CLOCK LEVEL (pause) BREAKING AWAY OUT (repeat)

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4. Slide-Under. In a similar way, at the end of an attack, a target may slide under a bomber to get itself in immediate position for another attack -- presenting an almost sure-shot target to the side gunner toward whose side he is sliding, providing he is forewarned. Report to the side gunner concerned like this.

attack (pause) clock and elevation position (pause) sliding under

ATTACK (pause) FOUR O'CLOCK LOW (Pause) SLIDING UNDER (repeat)

FIRE! At almost the same instant you are reporting enemy aircraft, you should be firing -- if they're within range. Remember that your gunnery equipment allows you to fire on anything within range. You don't have to wait for the fighter to attack you. If possible, knock him down while he's still maneuvering for position. If he attacks you or your formation, give him the works. If you don't get him, pass on the dope so that someone else can get him on the breakaway or slide-under.

The rules for delivering either defense or support fire are the same:

1. Set the true wingspan of the target on the target dimension dial.
2. Put the center dot of the reticle on the target's fuselage at the leading edge of its wings.
3. Adjust the range so that the circle of dots in your reticle just touch the part of the target farthest away from the center dot.
4. Make sure you won't hit any of your own bombers.
5. Open fire and keep firing in bursts.
6. If, in tracking the target, you come anywhere near one of your own bombers, remember the required safety rule for tracking toward and away from a friendly bomber -- stop firing one full hour clock angle tracking toward, hold five 1/2 hour clock angle tracking away.



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The tail gunner in B-29's equipped with radar detection equipment will be the only gunner able to report the presence of enemy or friendly aircraft on individual missions at night or in low or zero visibility.

He should report immediately by interphone the presence of a target within his cone of detection. Then, for the benefit of the crew, especially his pilot and radio operator, he should keep up a running report at 30 second intervals until the target is identified as friendly or enemy, and, if enemy, until it is evaded or destroyed. To report the target's range, he will use these set words: SPOT, if the target is beyond 900 yards; CLOSE, if it is between 900 and 500 yards; and the range in round numbers, if it is under 500 yards. His full report should go like this:

target (pause) range information (pause) clock and elevation position

TARGET (pause) SPOT (pause) SEVEN O'CLOCK HIGH (repeat)

TARGET (pause) CLOSE (pause) SIX O'CLOCK LEVEL (repeat)

TARGET (pause) FOUR HUNDRED (pause) FIVE O'CLOCK LOW (repeat)

Immediately upon TARGET report, the radio operator will issue the IFF challenge and report back to the tail gunner if the detected aircraft is found friendly. If the tail gunner gets no report from the radio operator, or if his signal lights (ELLA) don't go on, indicating that the target is not another B-29, the tail gunner will assume that any detected aircraft is a target and open fire if its range decreases to 600 yards. He will fire long bursts and continue to report on interphone as long as the target is within 600 yards, or until it is destroyed, evaded, or lost.





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How Areas of Search and Fire are Adjusted

You will always be instructed on the exact dimensions of your area of search and fire before every mission. Your general areas of search and fire are determined by the size, shape, spacing, and arrangement of the formation and the gunner-turret allocations used. In some positions in the formation your area will be cut down by the position of other bombers around you. In other positions you may have to shift your whole area slightly to get it out of the way of a neighboring bomber.

In all cases, however, you start with your assigned general area and adjust it to fit the situation. There are three general rules for adjusting your area of search and fire:

1. Your area is limited by the rule for restricting areas 1 full hour clock angle away from any other bomber in your formation.
2. All areas are adjusted in azimuth only, never in elevation -- with the single exception of the tail gunner's area -- as a safety precaution imposed by the staggering of formations high or low.
3. All areas, except the top gunner's, are adjusted by cutting down their size in azimuth. Only the top gunner can swing his whole area around in azimuth.

The next six pages show you how the areas of search and fire are determined for a single bomber flying alone and for various typical formations. Remember that these are merely typical examples, fitting the formations shown. The areas shown may vary from day to day and from mission to mission. A slight change in the spacing or stacking of bombers in a formation alone is enough to cause the areas of search and fire to be re-adjusted. For instance, the top gunner in Bomber 6 in the 11-plane formation shown in the following pages must reduce his search and fire area from 7-1 o'clock to 9-1 o'clock to avoid hitting Bomber 9, stacked higher in this high right formation, if the vertical spacing decreases.



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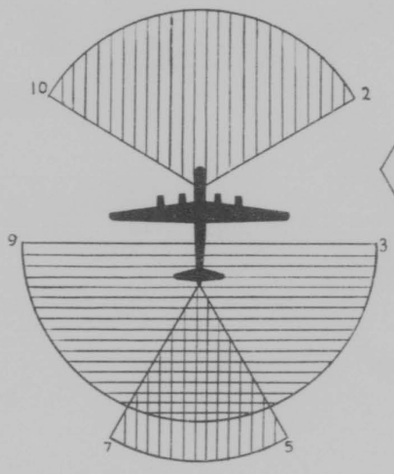
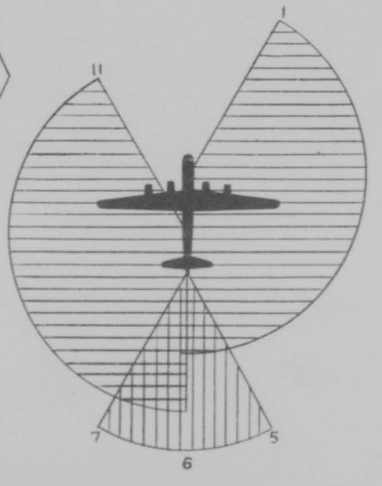
SINGLE BOMBER

ONE EACH ALLOCATION




UPPER DEFENSE: Nose Gunner controls UFT; top gunner controls UAT; tail gunner controls Tail Mount.

LOWER DEFENSE: Right side gunner controls LFT; left side gunner controls LAT; tail gunner controls Tail Mount.

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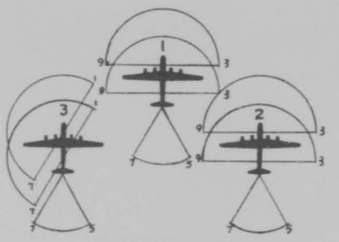
## 3 BOMBER FORMATION

STACKED HIGH RIGHT

HI-MAN ALLOCATION

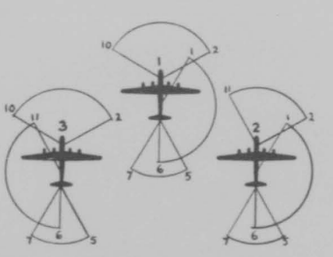


UPPER DEFENSE: Top gunner controls UFT and UAT; Tail gunner controls Tail Mount.

Top gunner in Bomber 3 swings his search and fire area to 7 - 1 o'clock in order to avoid hitting Bomber 1.

LOWER DEFENSE: Nose gunner controls LFT; side gunner controls LAT; Tail gunner controls Tail Mount.

Nose gunner in Bomber 2 cuts his search and fire area down to 11 - 2 o'clock to avoid hitting Bomber 1.



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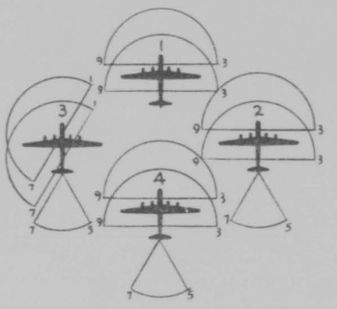
## 4 BOMBER FORMATION

STACKED HIGH RIGHT: BOMBER 4 HIGH — HI-MAN ALLOCATION



UPPER DEFENSE: Top gunner controls UFT and UAT; tail gunner controls Tail Mount.

Top gunner in Bomber 3 swings his search and fire area to 7 - 1 o'clock to avoid hitting Bomber 1.

Tail gunner in Bomber 1 does not search and fire above horizontal to avoid hitting Bomber 4.

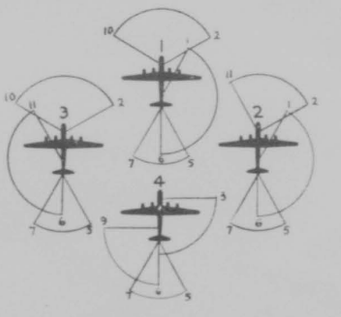
LOWER DEFENSE: Nose gunner controls LFT; side gunner controls LAT: tail gunner controls Tail Mount.

Nose Gunner in Bomber 2 cuts down his area of search and fire to 11 - 2 o'clock to avoid hitting Bomber 1.

Nose gunner in Bomber 4 is completely out because Bomber 1, 2 and 3 block all forward low fire.

Right side gunner in Bomber 4 takes over LFT from nose gunner and limits his search and fire area to 3 - 6 o'clock to avoid hitting Bomber 2.

Left side gunner in Bomber 4 cuts down his area to 6 - 9 o'clock to avoid hitting Bomber 3.



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## 4 BOMBER FORMATION

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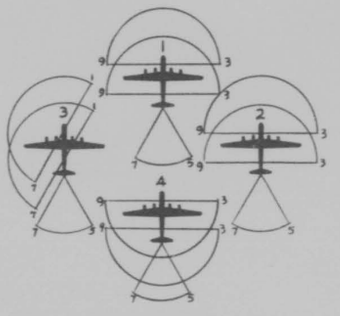


UPPER DEFENSE: Top gunner controls UFT and UAT; tail gunner controls Tail Mount.

Top gunner in Bomber 3 swings his search and fire area to 7 - 1 o'clock to avoid hitting Bomber 1.

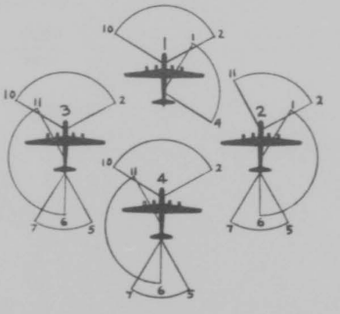
Top gunner in Bomber 4 swings his whole area completely around to the rear, 3 - 9 o'clock, because Bombers 1, 2 and 3 block all forward high fire.

LOWER DEFENSE: Nose gunner controls LFT; side gunner controls LAT; tail gunner controls Tail Mount.

Nose gunner in Bomber 2 cuts down his search and fire area to 11 - 2 o'clock to avoid hitting Bomber 1.

Right side gunner in Bomber 1 cuts down his area to 1 - 4 o'clock to avoid hitting Bomber 4.

Tail gunner in Bomber 1 cuts off his area below horizontal and searches and fires only above horizontal to avoid hitting Bomber 4.



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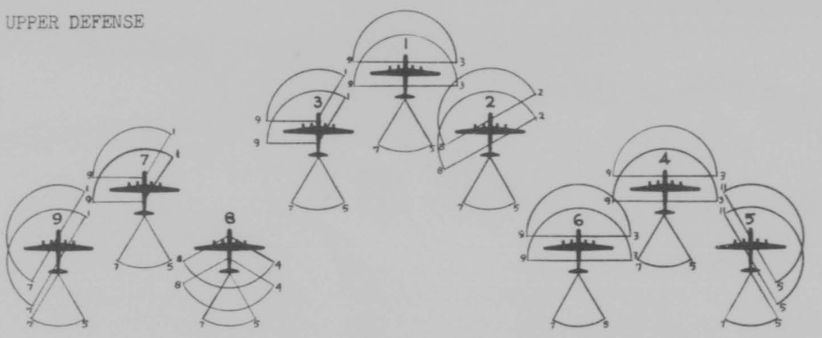
## 9 BOMBER FORMATION

STACKED HIGH RIGHT

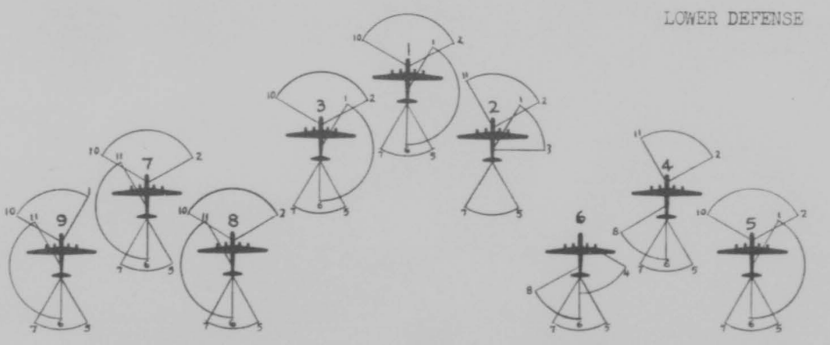
HI-MAN ALLOCATION

UPPER DEFENSE




Rear View

LOWER DEFENSE

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## 9 BOMBER FORMATION

UPPER DEFENCE: Top gunner controls UFT and UAT: tail gunner controls Tail Mount.

Bomber 2 top gunner swings area to 8-2 to avoid hitting Bomber 4.

Bomber 3 top gunner cannot swing his area because of Bomber 9, so he cuts area to 9-1 to avoid hitting Bomber 1.

Bomber 5 top gunner swings area to 11-5 to avoid hitting Bomber 4.

Bomber 7 top gunner cannot swing his area because of Bomber 9, so he cuts area to 9-1 to avoid hitting Bomber 3.

Bomber 8 top gunner swings whole area aft and cuts it to 4-8 to avoid hitting Bombers 9 and 6.

Bomber 9 top gunner swings area to 7-1 to avoid hitting Bomber 3.

LOWER DEFENCE: Nose gunner controls LFT; side gunner controls LAT; tail gunner controls Tail Mount

Bomber 2 nose gunner cuts area to 11-2 to avoid hitting Bomber 1.

Bomber 4 nose gunner cuts area to 11-2 to avoid hitting Bomber 2.

Bomber 6 nose gunner, to avoid hitting Bombers 2 and 4, gives up LFT to right side gunner, who cuts area to 4-6 to avoid hitting Bomber 5.

Bomber 9 nose gunner cuts area to 10-1 to avoid hitting Bomber 7.

Bomber 2 right side gunner cuts area to 1-3 to avoid hitting Bomber 5.

Bomber 4 right side gunner, to avoid hitting Bomber 5, gives LAT to left side gunner, who cuts area to 6-8 to avoid hitting Bomber 8.

Bomber 6 left side gunner cuts area to 6-8 to avoid hitting Bomber 8.

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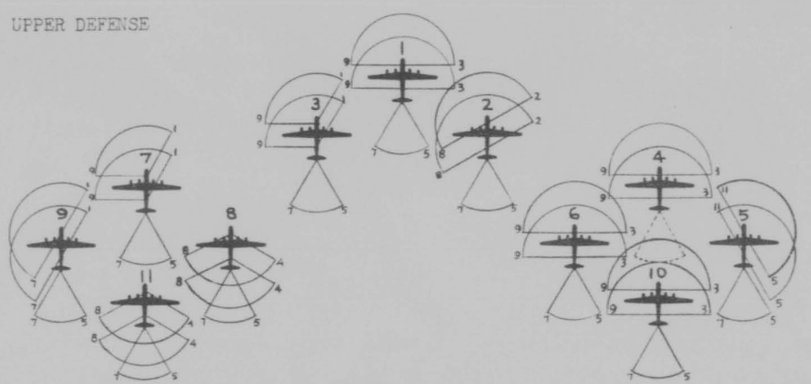
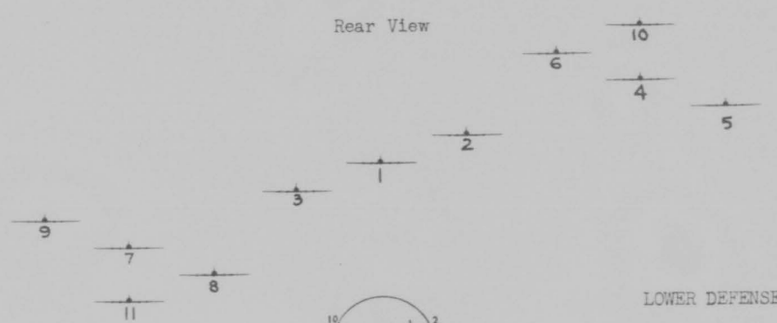
## 11 BOMBER FORMATION

HI-MAN ALLOCATION

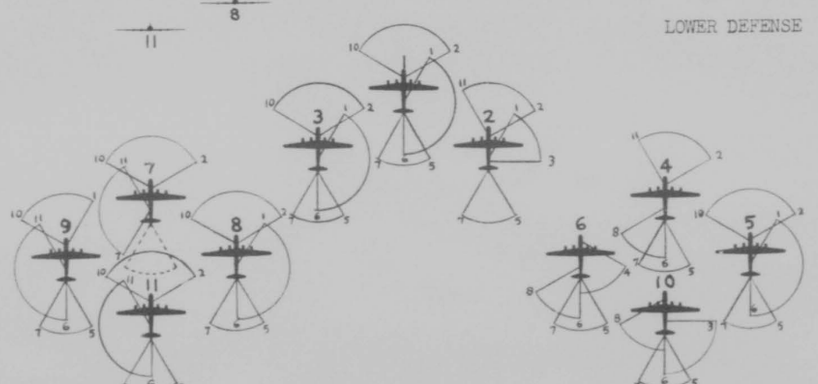
UPPER DEFENSE




Rear View




LOWER DEFENSE

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## 11 BOMBER FORMATION

UPPER DEFENCE: Top gunner controls UFT and UAT; tail gunner controls Tail Mount.

Bomber 2 top gunner swings area to 8-2 to avoid hitting Bomber 4.

Bomber 3 top gunner cannot swing his area because of Bomber 9, so he cuts area to 9-1 to avoid hitting Bomber 1.

Bomber 5 top gunner swings area to 11-5 to avoid hitting Bomber 4.

Bomber 7 top gunner cannot swing his area because of Bomber 9, so he cuts area to 9-1 to avoid hitting Bomber 3.

Bomber 8 top gunner swings whole area aft and cuts it to 4-8 to avoid hitting Bombers 9 and 10.

Bomber 9 top gunner swings area to 7-1 to avoid hitting Bomber 3.

Bomber 11 top gunner swings whole area aft and cuts it to 4-8 to avoid hitting Bombers 9 and 10.

Bomber 4 tail gunner does not fire in upper hemisphere to avoid hitting Bomber 10.

LOWER DEFENCE: Nose gunner controls LFT; side gunner controls LAT; tail gunner controls Tail Mount.

Bomber 2 nose gunner cuts area to 11-2 to avoid hitting Bomber 1.

Bomber 4 nose gunner cuts area to 11-2 to avoid hitting Bomber 2.

Bomber 6 nose gunner, to avoid hitting Bombers 2 and 4, gives LFT to right side gunner, who cuts area to 4-6 to avoid hitting Bomber 5.

Bomber 9 nose gunner cuts area to 10-1 to avoid hitting Bomber 7.

Bomber 10 nose gunner, to avoid hitting Bomber 4, gives LFT to left side gunner, who cuts area to 6-8 to avoid hitting Bomber 11.

Bomber 2 right side gunner cuts area to 1-3 to avoid hitting Bomber 5.

Bomber 4 right side gunner gives LAT to left side gunner, who cuts area to 6-8 to avoid hitting Bomber 11.

Bomber 6 left side gunner cuts area to 6-8 to avoid hitting Bomber 11.

Bomber 7 left side gunner cuts area to 7-11 to avoid hitting Bomber 11.

Bomber 10 right side gunner cuts area to 3-6 to avoid hitting Bomber 5.

Bomber 7 tail gunner does not fire in lower hemisphere to avoid hitting Bomber 11.



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Applied Mathematics Panel Study No. 181

# A SUGGESTED SYSTEM FOR BRIEFING B-29 FORMATIONS

Mount Wilson Observatory
Pasadena, California

April 24, 1945

Technical Report No. 14

This is not an Applied Mathematics Panel Report. It is a preliminary paper intended principally for persons immediately concerned with problems related to AMP Study No. 181.

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II. Statement of Conclusions and Suggested Briefing Rules.
III. Application of Suggested Briefing Rules to 11-Plane Formation.
IV. Discussion of Conclusions and Briefing Rules.
V. Comparison of Turret Allocations for Forward Defense.
VI. Importance of Vertical Spacing.

ILLUSTRATIONS

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Figure 1. Left-Hand Element High. Plane 10 Below Low Element.
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## I. INTRODUCTION.

This report presents a systematic method of briefing, intended to cover a wide variety of formations. This was developed in response to a request from XXI Bomber Command for a recommended briefing schedule for the 11-plane formation described in their Tactical Doctrine (Revised 24 Feb. 1945). It is an outgrowth of the system outlined in the Report of the Pasadena Conference, held by the Twentieth Air Force 15-26 Feb. 1945, but results in briefings more in spirit with our interpretation of the XXI Bombing Command Tactical Doctrine.

The suggested briefing plan which follows should be regarded as one way of simplifying and extending the Pasadena Conference system of briefing rules. The extension is the result of further study of the subject by members of the Mount Wilson Observatory Group, and has not been discussed with other members of the Pasadena Conference.

With the suggested briefing rules is included a discussion of the reasoning behind them. Their detailed application is illustrated by diagrams and tables showing the turret allocations and areas of search and fire which result for the 11-plane formation. The number of guns which this formation can bring to bear in various directions is given in tabular form.

This report considers only the formation with left-hand element stacked high. This agrees with a diagram received from XXI Bomber Command, but differs from the convention followed by the Pasadena Conference.

Note: After this report had been completed we were informed by Dr. Loughridge that the formation of most general interest at the present time is that with the right-hand element stacked high. Diagrams of the briefing for this stacking are therefore being added as an Appendix (Figs. 3 and 4, and Table 3). The discussion in the text still refers in every case to the high left stacking.

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II. STATEMENT OF CONCLUSIONS AND SUGGESTED BRIEFING RULES.

Fundamental Conclusions.

Consideration of the arguments given in Section IV below suggest the following conclusions:

1. Defensive fire should be concentrated forward, even at the expense of firepower in other directions.
2. Danger from friendly fire should be avoided wherever possible by restricting gunners' areas of fire.
3. These restrictions must be revised continually while in flight, as the formation changes size or shape.
4. Such revisions can be made effectively only by the gunners themselves.
5. A simple set of briefing rules is therefore needed which will
   a. be readily applicable by the gunners themselves during flight,
   b. accomplish (1) and (2),
   c. be suitable both for the standard formation and for any other formation likely to occur.

Suggested Briefing Rules.

The following set of briefing rules is believed to satisfy the requirements outlined in (5) above.

I. Turret Allocation.

A. Normal turret allocation: HI MAN.

B. Planes whose safe lower forward fire is limited to one-clock angle or less use ONE EACH.

C. On bombing run, lead and deputy lead planes use NOSE OUT.

D. The lower aft turret is controlled by the blister toward the outside of the formation, except when the safe area of fire is larger toward the inside.



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II. Areas of Search and Fire.

A. Search and fire areas are identical, except that the tail gunner's normal search area is limited only by visibility.

B. Azimuth limits are always at whole clock angles.

C. Standard areas of search and fire for each sighting station, which apply when friendly planes are not endangered, are:

1. Nose: 10 to 2 o'clock.

2. Ring: 180°, normally directed forward (9 to 3 o'clock).

a. If limited on one side by friendly fire restrictions, entire area is swung to the other side as far as necessary.

b. If limited to two-clock angles or less by friendly fire restrictions on both sides, area is directed aft.

c. On extreme wing ships, area is directed to the outside (6 to 12, or 12 to 6 o'clock).

3. Blisters: normally 1 to 6 or 6 to 11.

a. All blisters of lead element cover 9 to 12 or 12 to 3 (except on extreme wing ships of formation).

b. If limited by friendly fire restrictions to region forward of the beam, area is extended forward to 12 o'clock.

4. Tail: Area of fire: entire coverage of turret.
Area of search: entire region of visibility.

D. Friendly fire restrictions.

1. Lead allowance. One-half clock angle must be allowed between azimuth limit of area and any friendly plane.

2. Parallax Allowance. Ring or blister gunners controlling a forward turret must allow one full clock angle between forward limit of area and a nearby friendly ship (of same or adjacent element, within 400 ft.).

3. Decrease fire area to bring limit to a whole clock angle.



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## III. APPLICATION OF SUGGESTED BRIEFING RULES TO 11-PLANE FORMATION.

The Briefing Rules suggested in Section II have been applied to the 11-plane formation of the XXI Bomber Command. Detailed briefing schedules are shown in Table 1 and in Figs. 1 and 2 for this formation when the spare plane in the low element flies below its element and also when it flies above its element. The left-hand element is always shown stacked high.

It is to be expected that rules which are designed to apply satisfactorily to any formation will not always give the best briefing when applied to a particular formation. In the present case the areas assigned to three gunners would be slightly changed in a schedule drawn up "on paper." The ring gunners on Planes 7 and 11 would probably be more useful if their areas were swung one hour to the outside. The right blister gunner in Plane 2 could extend his area of fire one hour to 3 o'clock without endangering Plane 4. This is apparent when the clearance angle is observed from the turret. But the gunner is at the sighting station and applies the rules on the basis of what he sees from there.

It is not certain that the suggested rules would lead to equally satisfactory briefings for all other formations, particularly for smaller ones. But we believe that in all cases the rules will be generally successful in accomplishing the initial objectives of improving forward defense and reducing own formation damage.

A table of "gun counts" in various directions from the 11-plane formation is included as a basis for comparing the distribution of firepower with the proposed briefing with that given by other formations or other briefings. Such figures by themselves are not a reliable standard



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of comparison, since they take no account of many important factors in the problem. For example, no distinction is made between two turrets controlled by the same gunner and two turrets controlled by different gunners, although the latter situation is recognized as being more effective, particularly against coordinated attacks.

Also, gun counts do not consider own formation damage. The restrictions needed to avoid such damage obviously reduce overall firepower, so that gun counts will in general be lower when this danger is absent than when it is present. These factors and many more must be considered along with the gun counts when one system of briefing is compared with another. The following section contains a discussion of many such factors and their relation to the suggested briefing rules.

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Figure 1

11 Plane Formation of the XXI Bomber Command

Plane 10 Below Low Element.

Briefed by Rules Suggested by Mount Wilson Observatory

April 1945

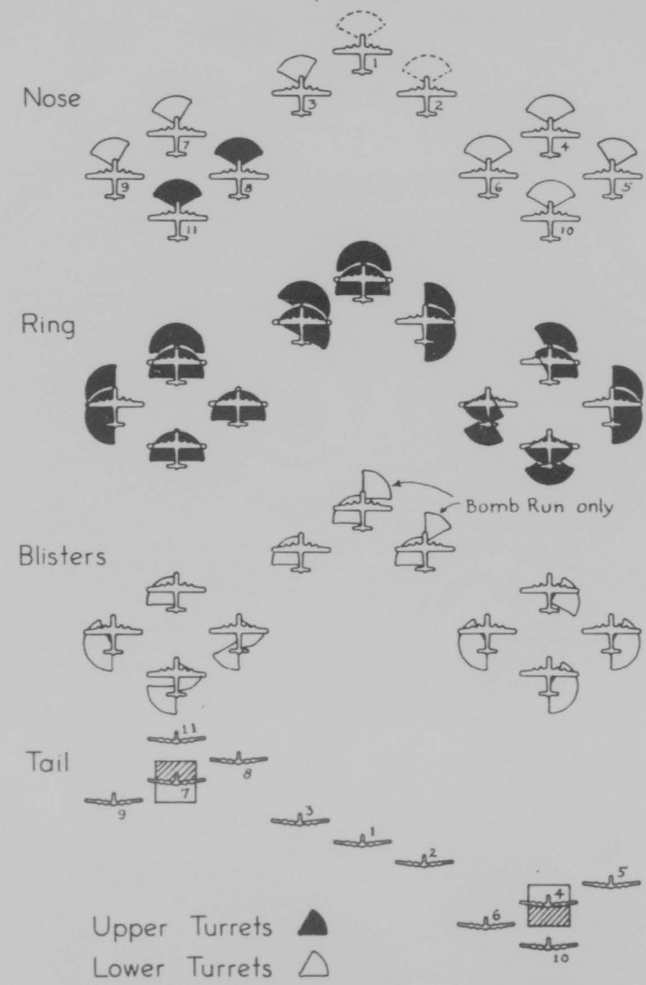


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Figure 2

11 Plane Formation of the XXI Bomber Command

Plane 10 Above Low Element.

Briefed by Rules Suggested by Mount Wilson Observatory

April 1945

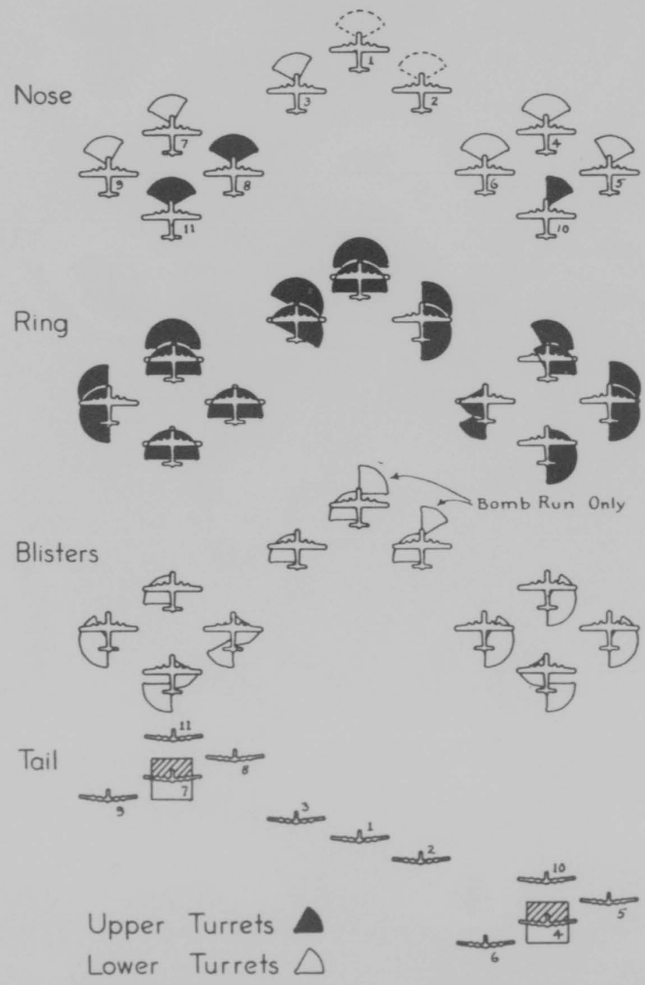


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TABLE 1.

11-PLANE FORMATION OF XXI BOMBER COMMAND STACKED HIGH LEFT
BRIEFED BY RULES SUGGESTED BY MT. WILSON OBSERVATORY-APRIL 1945

A. Plane 10 Below Low Element.

Table of Briefing-for Cruising

| Plane | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HI MAN | -- | 10-2 | 9-3 | 9-3 | -- | -- | -- | 9-12 | 5-7 | |
| 2 | HI MAN | -- | 10-2 | 12-6 | 12-6 | -- | -- | -- | 9-12 | 5-7 | |
| 3 | HI MAN | -- | 10-1 | 10-4 | 10-4 | -- | -- | -- | 9-12 | 5-7 | |
| 4 | HI MAN | -- | 10-2 | 11-3 | 11-3 | -- | 1-4 | -- | -- | 5-7 | Hi |
| 5 | HI MAN | -- | 11-2 | 12-6 | 12-6 | -- | 1-6 | -- | -- | 5-7 | |
| 6 | HI MAN | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 | |
| 7 | HI MAN | -- | 10-1 | 9-3 | 9-3 | -- | -- | -- | 9-12 | 5-7 | Lo |
| 8 | ONE EACH | 10-2 | -- | -- | 9-3 | 4-6 | -- | -- | 6-8 | 5-7 | |
| 9 | HI MAN | -- | 10-1 | 6-12 | 6-12 | -- | -- | -- | 6-11 | 5-7 | |
| 10 | HI MAN | -- | 10-2 | 4-8 | 4-8 | -- | 1-6 | -- | -- | 5-7 | |
| 11 | ONE EACH | 10-2 | -- | -- | 9-3 | 4-6 | -- | -- | 6-9 | 5-7 | |
| | Alternate for Bomb Run | | | | | | | | | | |
| 1 | NOSE OUT | -- | -- | 9-3 | 9-3 | 12-3 | -- | -- | 9-12 | 5-7 | |
| 2 | NOSE OUT | -- | -- | 12-6 | 12-6 | 12-2 | -- | -- | 9-12 | 5-7 | |
| | (Rest of Formation Same as Above.) | | | | | | | | | | |

B. Plane 10 Above Low Element.

Table of Briefing-for Cruising

| Plane | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HI MAN | -- | 10-2 | 9-3 | 9-3 | -- | -- | -- | 9-12 | 5-7 | |
| 2 | HI MAN | -- | 10-2 | 12-6 | 12-6 | -- | -- | -- | 9-12 | 5-7 | |
| 3 | HI MAN | -- | 10-1 | 10-4 | 10-4 | -- | -- | -- | 9-12 | 5-7 | |
| 4 | HI MAN | -- | 10-2 | 11-3 | 11-3 | -- | 1-6 | -- | -- | 5-7 | Lo |
| 5 | HI MAN | -- | 11-2 | 12-6 | 12-6 | -- | 1-6 | -- | -- | 5-7 | |
| 6 | HI MAN | -- | 10-2 | 6-8 | 6-8 | -- | 1-6 | -- | -- | 5-7 | |
| 7 | HI MAN | -- | 10-1 | 9-3 | 9-3 | -- | -- | -- | 9-12 | 5-7 | Lo |
| 8 | ONE EACH | 10-2 | -- | -- | 9-3 | 4-6 | -- | -- | 6-8 | 5-7 | |
| 9 | HI MAN | -- | 10-1 | 6-12 | 6-12 | -- | -- | -- | 6-11 | 5-7 | |
| 10 | ONE EACH | 12-2 | -- | -- | 12-6 | -- | 3-6 | 6-8 | -- | 5-7 | |
| 11 | ONE EACH | 10-2 | -- | -- | 9-3 | 4-6 | -- | -- | 6-9 | 5-7 | |
| | Alternate for Bomb Run | | | | | | | | | | |
| 1 | NOSE OUT | -- | -- | 9-3 | 9-3 | 12-3 | -- | -- | 9-12 | 5-7 | |
| 2 | NOSE OUT | -- | -- | 12-6 | 12-6 | 12-2 | -- | -- | 9-12 | 5-7 | |
| | (Rest of Formation Same as Above.) | | | | | | | | | | |

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TABLE 2. NUMBER OF GUNS WHICH CAN BE BROUGHT TO BEAR IN VARIOUS DIRECTIONS

11-Plane Formation of XXI Bomber Command Stacked High Left

Briefed by Rules Suggested by Mt. Wilson Observatory

A. Plane 10 Below Low Element

Briefed for Cruising

| | 10 11 12 1 2 | 3 4 | 5 6 7 | 8 9 o'clock |
|---|---|---|---|---|
| High | 20 26 22 32 30 | 20 10 | 29 40 27 | 6 10 |
| Level | 25 30 28 32 26 | 20 8 | 28 37 29 | 9 16 |
| Low | 20 27 22 18 12 | 6 7 | 23 38 23 | 7 9 |

Briefed for Bombing Run

| | 10 11 12 1 2 | 3 4 | 5 6 7 | 8 9 o'clock |
|---|---|---|---|---|
| High | 20 26 22 32 30 | 20 10 | 29 40 27 | 6 10 |
| Level | 23 26 24 28 26 | 22 8 | 28 37 29 | 9 16 |
| Low | 18 23 20 18 13 | 7 7 | 23 38 23 | 7 9 |

B. Plane 10 Above Low Element

Briefed for Cruising

| | 10 11 12 1 2 | 3 4 | 5 6 7 | 8 9 o'clock |
|---|---|---|---|---|
| High | 20 26 24 36 33 | 22 10 | 24 34 22 | 4 10 |
| Level | 23 28 26 31 26 | 22 12 | 30 38 26 | 6 14 |
| Low | 17 24 20 16 11 | 7 10 | 28 43 24 | 6 7 |

Briefed for Bombing Run

| | 10 11 12 1 2 | 3 4 | 5 6 7 | 8 9 o'clock |
|---|---|---|---|---|
| High | 20 26 24 36 33 | 22 10 | 24 34 22 | 4 10 |
| Level | 21 24 22 27 26 | 24 12 | 30 38 26 | 6 14 |
| Low | 15 20 18 16 12 | 8 10 | 28 43 24 | 6 7 |

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IV. Discussion of Conclusions and Suggested Briefing Rules.

This section gives the reasoning which leads to the five Conclusions and to the detailed Briefing Rules which are suggested as a means of carrying them out.

Conclusion 1. Defensive fire should be concentrated forward, even at the expense of fire-power in other directions.

ARGUMENT:

The direction in which the maximum firepower should be turned depends upon (a) the frequency of enemy attacks, (b) the effectiveness of enemy attacks, and (c) the effectiveness of our fire.

(a) Frequency of Enemy Attacks.

Combat reports summarized in the Pasadena Conference Report, Inclosure 10, show that the recent enemy attacks are principally from the forward region, especially from nose high.

(b) Effectiveness of Enemy Attacks.

Although pursuit curves from the nose are necessarily of very short duration, they are evidently effective. On Missions 1-27 of XX Bomber Command, out of 8 attacks from known directions leading to loss of B-29's from enemy gunfire, 6 were from nose high and the other 2 from nose low. (See Pasadena Conference Report, Inclosure 12.)

From theoretical study, enemy attacks are believed to be most lethal from the tail and least lethal from the beam. This is due to the fact that tail attacks can be pursuit curves; whereas beam attacks within effective range must be strafing attacks. The enemy's preference for nose rather than tail attacks may be due to a higher rate of survival for this tactic.

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(c) Effectiveness of Our Fire.

The relative effectiveness of our guns in various directions is a natural consequence of the mechanics of fighter attack and of the limitations of the C.F.C. system.

Nose attacks occur suddenly and are of short duration because of the high closing rate (about 1000 feet per sec.). Sudden attacks cause gunners to slew their guns to get on the target, setting up spurious leads in the computer. The time required by the computer to recover and provide correct leads may be the entire duration of the attack. This can be particularly bad if attacks from this quarter are coordinated.

Beam attacks, as well as breakaways from nose attacks which pass through this region will, in general, require leads in excess of 200 mils, which is the present computer limit. Thus our fire in this region is ineffective. Fortunately enemy attacks in this region are also of less importance.

Against tail attacks the C.F.C. system is at its best, and the enemy appears to be aware of it. The tail guns fill this area adequately. It seems unnecessary to divert other guns to this region.

The system of briefing in the present Tactical Doctrine (Revised 24 Feb.) clearly recognizes the importance of forward defense. The Briefing Rules proposed by the Pasadena Conference also emphasize forward fire, but do not carry this as far as is done in the present suggestion. Our general policy has been to make available for forward defense every gun that can be used effectively in that region. Because of friendly fire restrictions and other considerations, this principle still directs many guns toward the beam and some toward the rear.



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In this connection the potentialities of the tail turrets should not be neglected. It has been pointed out here and verified by O.A.S., XXI Bomber Command, that aggressive attacks from any direction necessarily pass through the tail cone. This is due to the high speed of the B-29, and the effect becomes more as the altitude increases. If this fact is thoroughly exploited the tail turrets should be able to increase the total firepower against nose and beam attackers.

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Conclusion 2. Danger from friendly fire should be avoided wherever possible by restricting gunners' areas of fire.

ARGUMENT:

The C.F.C. system (of sight feeding into computer, and computer pointing gun) does not give the gunner any good idea of where his guns are pointed. The divergence of his guns from his line of sight may exceed 200 mils, which is more than can be seen through his sight. To avoid hitting a friendly ship he must sometimes stop firing before he can see it. He must therefore know in advance the limits within which he can fire safely, and he must cease fire before the target passes beyond these limits.

When each gunner is assigned an area of fire, defined by easily recognized boundaries, he should become accustomed to thinking of safe fire in terms of this area, rather than in terms of the avoidance of individual friendly ships. Instead of complicating his problem, this should simplify it, and hence increase the effectiveness of his fire within the assigned region.





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The fact that the area of fire is limited, sometimes severely, reduces the intensity of fire that the formation can bring to bear in certain directions. But there are times when a gunner must remember to leave destruction of B-29's to the Japs even if this means leaving destruction of the Jap to some other gunner.

Fortunately, most of the restrictions needed to avoid friendly fire are toward the beam, where tracking rates are high and accuracy of fire low, and where enemy attacks are both infrequent and ineffective. When fire toward the beam would endanger friendly ships it is certainly better not to fire.

In some cases even fire at targets within the nose region is dangerous. Here the choice is less obvious, since defense against nose attacks is needed badly. But to apply different standards of safety in different regions would cause confusion. Therefore the avoidance of friendly fire is given precedence over volume of fire-power toward the nose as well as in other directions.

Conclusion 3. These restrictions must be revised continually while in flight, as the formation changes size or shape.

ARGUMENT:

We understand from information from the combat theatre that the difficulties of take-off and assembly are such that the formations which actually encounter the enemy vary in number from two or three planes to more than twelve, and that the formations which assemble close to or within enemy territory are also variable in form. The 11-plane formation is referred to as a 9-plane formation with two spares. The Tactical Doctrine gives specific instructions as to how



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losses in the formation shall be filled. It is apparent that gunners will frequently have to redefine their areas of search and fire to fit the circumstances in which they find themselves.

Even when a formation is definitely established it cannot maintain its prescribed shape under all conditions. Some variations are necessary to conserve gasoline. The formation may become distorted on turns, which must sometimes be made while under attack. If a plane is damaged and drops back in the formation, it is particularly important that its own fire and that of the formation remain as effective as possible. All of these conditions demand a frequent and almost automatic readjustment of areas of fire.

Conclusion 4. Such revisions can be made effectively only by the gunners themselves.

ARGUMENT:

It has sometimes been assumed that areas of search and fire would be assigned to each gunner by the copilot or by the command gunner. But usually it is not possible for any one man on a B-29 to observe the positions of all other planes in the formation. It would then be necessary for gunners to report the direction of friendly ships and receive instructions as to areas of fire based on these reports.

We believe that any such proceedure would be both slow and inaccurate, and that there would be a strong tendency for the gunners to adjust their own areas as conditions changed. If they can judge angles well enough to report them satisfactorily, they should have no trouble with the other steps in the process.

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If the gunners are given individual responsibility for determining safe limits of fire they will be more inclined to observe them.

Conclusion 5. A simple set of briefing rules is therefore needed which will:

a. be readily applicable by the gunners themselves during flight,
b. accomplish (1) and (2),
c. be suitable both for the standard formation and for any other formation likely to occur.

ARGUMENT:

This conclusion follows directly from (3) and (4).

The value of such rules has already been recognized in the Tactical Doctrine of the XX Bomber Command which states general instructions for turret allocation and areas of search and fire for application when the standard formation is not being flown. (See, for example, Inclosure 4 of the Pasadena Conference Report)

If details of the briefing for all situations likely to arise can be covered by a satisfactory set of rules, then the same rules can also be used for the standard formation. It is then unnecessary to carry diagrams or tables showing details of the briefing even for the standard formation. This is a simplification which may be especially important if it is felt that such information would be of value to the enemy.

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I. Turret Allocation.

A. Normal Turret Allocation: HI MAN.

ARGUMENT:

This turret allocation is already in use by XXI Bomber Command. A comparison of various turret allocations (see Section V below) supports the selection of HI MAN as offering the best defensive fire forward.

B. Planes whose safe lower forward fire is limited to one clock angle or less use ONE EACH.

ARGUMENT:

For high rear ships on which the lower forward turret cannot fire forward effectively the disadvantages of ONE EACH do not apply. This allocation is then better than HI MAN, since it offers diversification in the upper hemisphere and more efficient use of the upper forward turret near the forward horizon.

It is recognized that the introduction of an additional allocation is a disadvantage, but the gain in firepower is believed to justify this slight complication. In the 11-plane formation this rule applies to the inside plane of the high element and to the two spares if they fly high in their elements.

C. On bombing run, lead and deputy lead planes use NOSE OUT.

ARGUMENT:

This allocation agrees with present practice and its advantages are self-evident.

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D. The lower aft turret is controlled by the blister toward the outside of the formation, except when the safe area of fire is larger toward the inside.

ARGUMENT:

This rule merely makes definite whether the turret allocation should be "right" or "left." It directs most of the lower turrets toward the outside of the formation, but turns a reasonable number toward the inside to guard against sneak attacks from below.

II. Areas of Search and Fire.

A. Search and fire areas are identical except that the tail gunner's normal search area is limited only by visibility.

ARGUMENT:

In the past, areas of search and areas of fire have usually, but not always, coincided. An argument can be made for allowing the search area to extend beyond the fire area. The C.F.C. system is designed to allow tracking outside of the area of coverage of the turret, to give continuity of computer operation as the target enters the area of fire. To take advantage of this principle, the search area should extend beyond the fire area in those directions from which targets are likely to approach.

To extend search areas in azimuth beyond fire area limits required by friendly fire restrictions would cause confusion and encourage the gunners to fire outside their assigned areas of fire. Therefore the reduced efficiency of fire near the forward boundary of these areas must be accepted.

To extend areas of search beyond the horizontal turret limitations would not endanger friendly ships and would improve defense

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against targets crossing the horizon. In addition, the greater overlap of upper and lower gunner's search areas should be valuable. However, the specification of area limitations would be less direct. Largely for this reason, and to avoid changing present practice, it seems best to keep search and fire areas identical for all except the tail gunner. For him continuity of tracking across the edge of his fire area is essential.

B. Azimuth limits are always at whole clock angles.

ARGUMENT:

Although the allowance for lead is taken as half of a clock angle, it is considered unrealistic to designate areas of search and fire in smaller units than whole hours. A gunner may be able to estimate half hours in determining his safe limits of fire, but while he is actually firing he can scarcely distinguish, for example, between 2 o'clock and 2:30.

The use of whole clock angles for all azimuth limits reduces the resulting areas in many cases. But since the safety of other ships in the formation depends upon the gunner's ability to visualize clearly his assigned area of fire while under attack, the simplicity that is gained makes up for the reduction of some areas.

C. Standard areas of search and fire for each sighting station, which apply when friendly planes are not endangered, are:

1. Nose, 10 to 2 o'clock.

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ARGUMENT:

Present Tactical Doctrine gives nose gunners the area from 9:30 to 2:30. The reduction to 10 to 2 is primarily to bring the limits to whole clock angles; but in addition we feel that increased concentration of attention and fire near 12 o'clock is more valuable than the area lost toward the beam.

By the time a nose gunner has tracked an attacker to two o'clock he will, in general, have reached the computer limit of 200 mils. Because of this and the awkwardness of the gunner's position when sighting toward the beam, we doubt if his fire is effective enough to warrant continued tracking. The large divisions between the panes of the greenhouse become serious obstructions near the beam, where rapid tracking will preclude his moving the sight to avoid them. It is therefore better for him to get back in position for the next attack.

2. Ring, 180° normally directed forward (9 to 3 o'clock).

   a. If limited on one side by friendly fire restrictions, entire area is swung to the other side as far as necessary.
   b. If limited on both sides by friendly fire restrictions allowing 2 clock angles or less, area is directed aft.
   c. On extreme wing ships, area is directed to the outside (6 to 12, or 12 to 6 o'clock).

ARGUMENT:

The limitation of the ring gunner to 180° is already accepted practice. The reasons for limiting the nose gunner to a smaller area do not apply so much to the ring gunner, who is also needed for defense against high attack out of the sun.

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The usual device of swinging the areas of ring gunners to the outside on ships near the edge of the formation is not followed (except for extreme wing ships), because of the complication in specifying what angles should be used in each case. However, the rules for avoiding own formation damage accomplish much the same result automatically, providing defense of the flanks and upper rear. Rule (c) insures that there will always be at least two turrets to cover each high flank.

Against coordinated nose attacks we feel that some gunners should stop tracking early and get ready for the next attacker, while others should track past the beam in the hope of obtaining hits at close range, in spite of the difficulty of such shots. The different orientations of ring gunners' areas should provide a useful variety of tracking techniques.

When the forward fire of the ring gunner is too limited it is probably better to have his fire concentrated on high tail attacks, as required by rule (b). In no formation likely to be flown will there be many ships who will have occasion to use this rule, which applies generally to the inside wing ship of the low element, and to a spare ship flying low in its element.

3. Blisters, normally 1 to 6 or 6 to 11.

   a. All blisters of lead element cover 9 to 12 or 12 to 3 (except on extreme wing ships of formation).
   b. If limited by friendly fire restrictions to region forward of the beam, area is extended forward to 12 o'clock.

ARGUMENT:

A blister gunner in normal attitude cannot search the area from the wing tip to the tail and at the same time cover the extreme forward area under the wing. However, he should watch as far forward as he rea-



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sonably can, in order to pick up targets early and track them through. The exact forward limit which should be set is hard to determine; the figure of one clock angle from the nose is in general agreement with present doctrine.

The practice of XXI Bomber Command of directing the whole attention of certain blister gunners toward the nose appears to be a valuable way of increasing forward defense. In formations in which the lead element is protected on both flanks by other planes the leader will be subject principally to nose attacks. The main function of the gunners of the lead element is to protect the lead ship. Therefore in spite of the relative ineffectiveness of the blisters in the forward area we feel that this briefing serves a useful purpose, and that it may well be extended to all three planes of the lead element.

This implies that these gunners will kneel facing forward. Since in this attitude they will have trouble tracking aft of the beam, their areas are limited to the forward hemisphere even when friendly ships are not in the way.

Similar reasoning leads to rule (b), which merely recognizes that if a blister gunner cannot fire aft of the beam he will be able to cover the extreme forward area and will be more effective if he does so.

4. Tail, area of fire: entire coverage of turret; area of search: entire region of visibility.

ARGUMENT:

The importance of continuity of tracking of targets entering the area of fire has already been pointed out. This requires that for the tail gunner the area of search be larger than the fire area.

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D. Friendly fire restrictions.

1. Lead Allowance. One-half clock angle must be allowed between azimuth limit of area and any friendly plane.

ARGUMENT:

Own formation damage cannot be prevented by the mere exclusion of friendly ships from areas of search and fire. When a lead or parallax correction is introduced by the computer, the direction of fire is different from the line of sight. If a gunner fires at a target which he has tracked all the way to the edge of his assigned area of fire, his actual direction of fire will in general be outside of this area. In many cases the guns will be 200 mils (11.3°) ahead of the sight because of lead alone. The parallax corrections may add another 60 mils (3.4°) to this angle. This makes half a clock angle, and cannot safely be neglected.

For this reason the azimuth limits of each area of search and fire should be sufficiently restricted to exclude friendly ships not only from the area itself, but also from a band 15° wide along the boundaries of the area. (This does not apply to boundaries formed by turret limitations, since regardless of computer action the guns are unable to fire beyond such boundaries.)

2. Parallax Allowance. Ring or blister gunners controlling a forward turret must allow one full clock angle between forward limit of area and a nearby friendly ship (of same or adjacent element, within 400 ft.).

ARGUMENT:

In determing friendly fire restrictions, clock angle limits should really depend upon the direction of the friendly ship from the

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turret rather than from the sighting station. Since this is impractical, observations are made from the sighting station and a correction is added in those cases in which a friendly plane would be endangered. Rule (2) specifies these cases (which turn out to be very few) and provides an extra allowance of 1/2 clock angle.

To take a specific case, consider the friendly fire restriction which the ring gunner on Plane 10 (flying low) must apply in order to clear Plane 5. Application of Rules (1) and (3) alone would place the forward limit of his area at 3 o'clock. If he opened fire with the sight aimed at 3 o'clock and the computer introducing a maximum lead toward the nose (as a result of slewing, for example), the guns would then point approximately to 2:30. This would leave an ample margin of safety for fire from the upper aft turret, which is near the sighting station. But fire toward 2:30 from the upper forward turret would endanger Plane 5.

Rule (2) applies in the case just described, because: (1) the ring gunner controls a forward turret, (2) the area limit concerned is the forward limit, (3) the plane endangered is a nearby plane, in this case belonging to the same element and only 150 feet away. Therefore a full clock angle is allowed, measured from the direction of the friendly ship as seen from the sighting station. This brings the limit a little aft of 3 o'clock. The nearest safe whole clock angle is therefore 4 o'clock. This is the limit shown in the table and diagram.

In the 11-plane formation (with Plane 10 low) this rule applies only to the ring gunners of Planes 6 and 10. Areas of other ring gunners do not have any forward limits set by friendly fire restrictions. Right

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blister gunners on Planes 8 and 11 control forward turrets and have forward limits set by friendly fire restrictions, but the planes endangered are too distant to come under the rule. The parallax allowance that they would need is small enough to be neglected.

When Plane 10 flies above its element, the Parallax Rule applies to the ring gunner in Plane 6, but happens not to change the limit which he would determine without it. The rule also applies to the left blister gunner in Plane 10, whose forward limit is changed from 3 to 4 o'clock. (3 o'clock fails by a very small margin to satisfy the rule.)

(It may be more satisfactory on the whole to omit this rule entirely and accept the small probability of damage that would result in the few cases to which it applies. An argument for doing this is that only forward limits are involved. When targets are tracked toward the nose the lead will ordinarily be low. Only when a spurious lead is set up by the computer as a result of slewing is the regular lead allowance of 1/2 clock angle likely to be needed. After such slewing the gunner should allow time for the computer to settle down before he opens fire. If he can be counted on to do this, the regular lead allowance should in general provide enough margin to cover the requirements for parallax.

In formulating the suggested rules it seemed preferable to provide for a parallax allowance, in order to show clearly what this would involve. If the complication of this provision is considered a serious disadvantage, we feel that it could reasonably be omitted entirely.)

3. Decrease fire area to bring limit to a whole clock angle.

ARGUMENT:

Reasons for the use of whole clock angles have already been given.

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V. Comparison of Turret Allocations for Forward Defense.

Of the six turret allocations having recognized descriptive names (see, for example, Inclosure 13 of the Pasadena Conference Report) the three which offer special advantages for forward defense are PRIMARY, ONE EACH, and HI MAN.

1. Under PRIMARY allocation, the nose gunner controls both forward turrets. This makes effective use of their 10° region of overlap, since continuity of tracking across this region is encouraged. However, outside of this region of overlap only one turret can be used at a time, the other one remaining idle. This results in a serious lack of diversification against simultaneous attacks from nose high and nose low. On the other hand there is good diversification in the upper hemisphere, since the two upper turrets are controlled by different gunners and can therefore fire at two simultaneous passes.

From the point of view of coverage forward, PRIMARY allocation is satisfactory unless restrictions are needed to avoid friendly fire. Due to the type of vertical stacking ordinarily used, the restrictions needed by the upper turret are usually different from those needed by the lower turret. But the nose gunner cannot be expected to recognize one set of azimuth limits in the upper hemisphere and another set in the lower. It is therefore necessary to restrict the fire of both turrets to an azimuth range in which neither one endangers friendly ships. This reduces coverage in the forward region and loses an important advantage of the vertical stacking that is used.

2. ONE EACH has the same diversification as PRIMARY in the upper hemisphere. But below the horizon it is handicapped by the

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assignment of the lower forward turret to a blister gunner. Although this provides diversification in the sense that the two forward turrets are controlled by different gunners, this is of little practical importance, because of the restricted coverage. Fire from the blister station is confined to one side or the other of the ship, and vision forward is limited by the wings to the area 10° or more below the horizon. Some protection is offered against low nose attacks, but far less than under PRIMARY.

3. HI MAN allocation gives the strongest defense against low nose attacks, since the nose gunner concentrates entirely upon this one region. This is not necessarily a great advantage, since low attacks are both less frequent, and at present less destructive than those from nose high. Under HI MAN there is good diversification against coordinated high and low nose attacks. However, in the upper hemisphere only one target can be attacked at a time. This allocation is therefore weak against high coordinated attacks, whether from the same or from different directions. This is the most important criticism of HI MAN. It is a more serious limitation in small formations than in large ones, since the presence of support fire provides effective diversification.

With respect to coverage, HI MAN has one slight disadvantage. The upper forward turret, when controlled by the nose gunner (as under PRIMARY or ONE EACH), covers the forward area above the horizon and 5° below it. Under HI MAN, with this turret assigned to the ring gunner, this 5° zone below the horizon is impaired by the wings, engine nacelles and forward fusilage. This limitation would be more serious if the region affected were not well covered by the 5° up-fire of the lower forward turret controlled by the nose gunner.



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If counts of guns bearing at various points of the sky are used as a standard of comparison between HI MAN and ONE EACH, it will be found that in the upper hemisphere the former gives higher values. This is because the upper forward turret covers 180° when controlled by the ring, but a smaller range (120° in the suggested system of briefing) when controlled by the nose. The higher gun counts under HI MAN are mainly toward the beam. This difference in coverage is of little practical importance since defense against nose attacks is the primary consideration.

4. In conclusion, for general defense against nose attacks, high level, and low, HI MAN is without doubt the best allocation. If level and high zones are given greater weight than low, in accordance with the reported distribution of attacks, HI MAN is still preferable, though the choice is less clear Under this condition PRIMARY has the advantage of offering diversification high; but coverage is reduced, since areas of fire must be limited above the horizon to match those below. ONE EACH also provides diversification against nose high attacks; but if low attacks are to be considered at all, the weakness of ONE EACH below the horizon more than offsets the gain.

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VI. Importance of Vertical Spacing.

1. Danger from 5° Overlap of Turrets.

Since the lower turrets fire 5° above the horizon, and the upper forward turret 5° below, the vertical spacing of ships in a formation must be sufficient to give clearance for this overlap. The standard 50-foot spacing leaves a safe margin in most cases. However, if two planes are adjacent vertically, but widely spaced horizontally, the 5° overlap may become dangerous.

For example, in the present 11-plane formation (stacked high left and with Plane 10 low), Planes 2 and 5, and also Planes 3 and 9, are 490 ft. apart horizontally but only 50 ft. vertically. This makes an angle of just under 6°. Subtracting the 5° overlap, the remaining margin of clearance is only 7 feet, which is too little for safety, and fails completely to clear the stabilizer on the lower ship.

Two planes which are spaced in this way should be treated in the briefing as if they were at the same level. Both upper and lower turrets of each plane should be briefed to clear the other.

The suggested briefing rules do not provide specifically for such situations, but the most obvious cases of danger are avoided nevertheless. Plane 5 is not really endangered by the upper turrets of Plane 2 because the upper aft turret has no down fire and the propeller blocks cut out the fire from the upper forward in the particular azimuth region concerned. The lower turrets of Plane 3 are both briefed forward and are therefore clear of Plane 9.

Own formation damage due to the 5° overlap is unlikely if the prescribed vertical spacing is maintained. But we understand that formations are generally flown flatter than is prescribed. If this tendency is carried far, the hazard becomes serious.



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2. Position of "Spare Ships."

The fact that two B-29 turrets cover essentially the upper hemisphere and two others essentially the lower hemisphere places special importance on the type of vertical stagger of the formation. If, for example, the ships of a formation are so stacked that when viewed from the rear they form a straight line, stacked high on the left, then the upper turrets on all ships can fire freely to the right while lower turrets can all fire freely to the left. Each turret can cover a full 180° in azimuth without danger of own formation damage. Such an arrangement of the ships will lead to a maximum figure for total firepower over the whole sky.

However, the defense fire of such a linear formation is very weak along the line of planes, or to the upper left and lower right. The plane at each end of the line receives no support fire against an attacker from these directions. Largely for this reason the pattern of vertical stagger is so modified as to break up the single line. The present 11-plane formation is a good example of such a broken pattern. Omitting the two spare ships, it provides unobstructed fire from three ships to the upper left and lower right, effectively protecting the ends of the formation.

However, it should be noted that the breaking up of this pattern imposes restrictions upon the firepower. Thus the upper turrets on Planes 4 and 6 and the lower turrets on Planes 7 and 8 are free neither to the right nor to the left. The resulting reduction of overall firepower is the cost of obtaining a more uniform distribution of the defense.

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This has a bearing on the most favorable positions for the two spare ships (Planes 10 and 11). If they fly on the outside of the formation in a vertical sense (the extra plane in the low element flying low and that in the high element flying high) they obstruct the protection of the ends of the formation. In this arrangement the rear view of the formation consists of five lines instead of three. The pattern has been broken up more than is desirable.

On the other hand, if the spare ships fly inside their elements in a vertical sense, the pattern of the formation consists of only three lines, just as it does when the spare ships are absent. The central line consists of five ships instead of three. Defense of the ends of the formation is preserved.

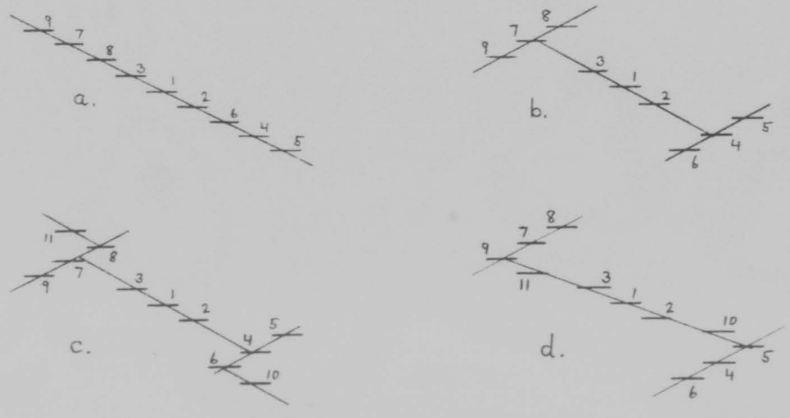


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Figure 3

11-Plane Formation of the XXI Bomber Command

Plane 11 **Below** Low Element.

Briefed by Rules Suggested by Mount Wilson Observatory

April 1945

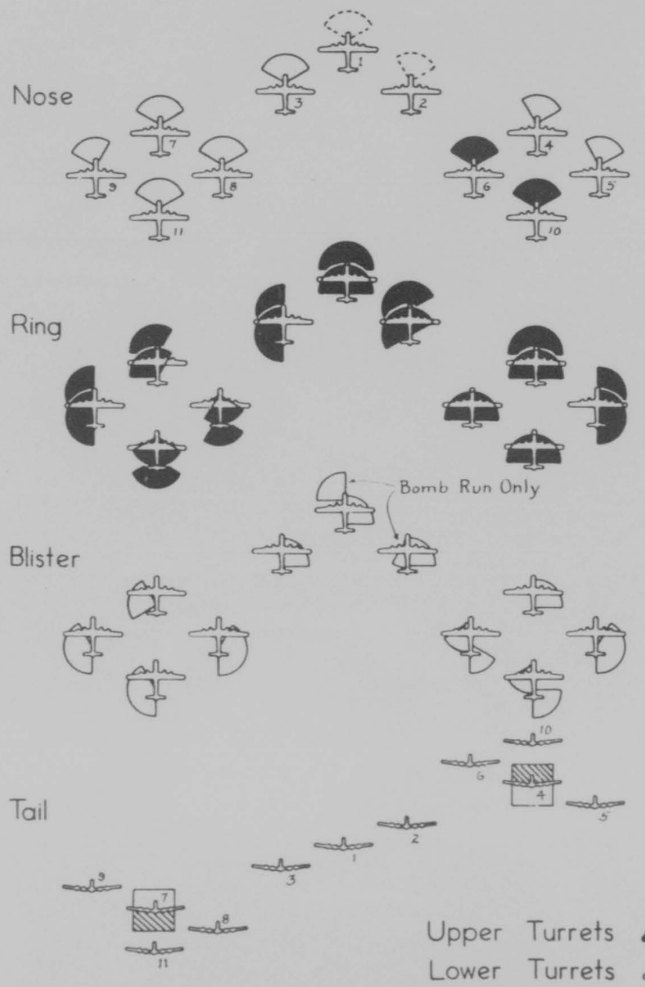


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Figure 4

11-Plane Formation of the XXI Bomber Command

Plane 11 **Above** Low Element

Briefed by Rules Suggested by Mount Wilson Observatory

April 1945

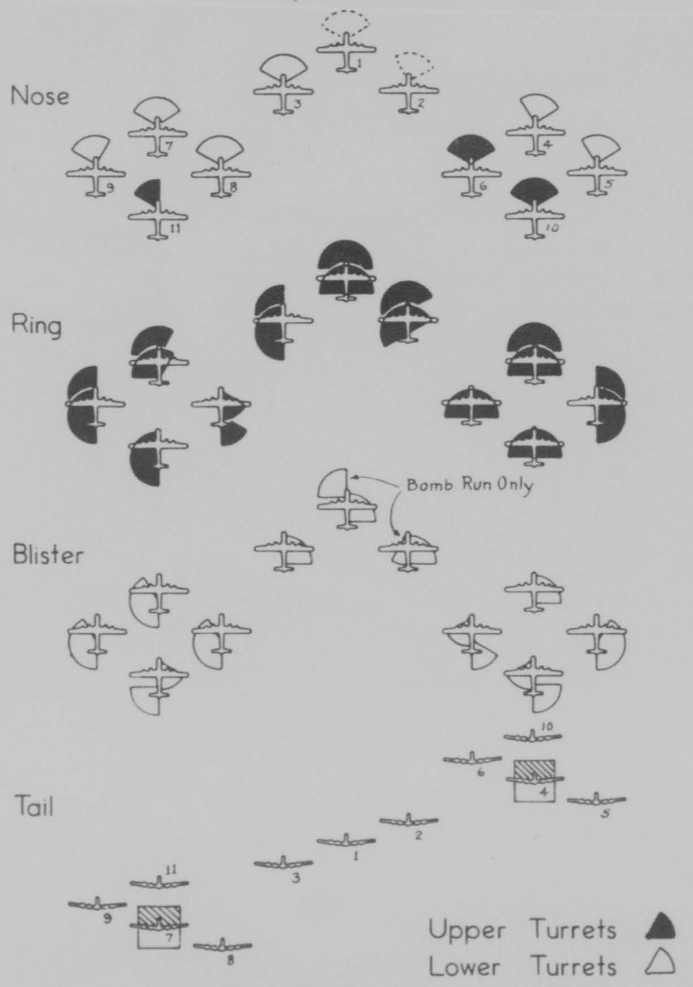


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TABLE 3. 11-PLANE FORMATION OF XXI BOMBER COMMAND

Right-Hand Element High

BRIEFED BY RULES SUGGESTED BY MT. WILSON OBSERVATORY

A. Plane 11 Below Low Element.

Briefed for Cruising

| Plane | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HI MAN | -- | 10-2 | 9-3 | 9-3 | -- | 12-3 | -- | -- | 5-7 | |
| 2 | HI MAN | -- | 11-2 | 8-2 | 8-2 | -- | 12-3 | -- | -- | 5-7 | |
| 3 | HI MAN | -- | 10-2 | 6-12 | 6-12 | -- | 12-3 | -- | -- | 5-7 | |
| 4 | HI MAN | -- | 11-2 | 9-3 | 9-3 | -- | 12-3 | -- | -- | 5-7 | Lo |
| 5 | HI MAN | -- | 11-2 | 12-6 | 12-6 | -- | 1-6 | -- | -- | 5-7 | |
| 6 | ONE EACH | 10-2 | -- | -- | 9-3 | -- | 4-6 | 6-8 | -- | 5-7 | |
| 7 | HI MAN | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 8-11 | 5-7 | Hi |
| 8 | HI MAN | -- | 10-2 | 4-7 | 4-7 | -- | 1-6 | -- | -- | 5-7 | |
| 9 | HI MAN | -- | 10-1 | 6-12 | 6-12 | -- | -- | -- | 6-11 | 5-7 | |
| 10 | ONE EACH | 10-2 | -- | -- | 9-3 | -- | 3-6 | 6-8 | -- | 5-7 | |
| 11 | HI MAN | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 | |
| | Briefed for Bombing Run | | | | | | | | | | |
| 1 | NOSE OUT | -- | -- | 9-3 | 9-3 | -- | 12-3 | 9-12 | -- | 5-7 | |
| 2 | NOSE OUT | -- | -- | 8-2 | 8-2 | -- | 12-3 | 6-7 | -- | 5-7 | |
| | (Rest of Formation Same as Above) | | | | | | | | | | |

B. Plane 11 Above Low Element.

Briefed for Cruising

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HI MAN | -- | 10-2 | 9-3 | 9-3 | -- | 12-3 | -- | -- | 5-7 | |
| 2 | HI MAN | -- | 11-2 | 8-2 | 8-2 | -- | 12-3 | -- | -- | 5-7 | |
| 3 | HI MAN | -- | 10-2 | 6-12 | 6-12 | -- | 12-3 | -- | -- | 5-7 | |
| 4 | HI MAN | -- | 11-2 | 9-3 | 9-3 | -- | 12-3 | -- | -- | 5-7 | Lo |
| 5 | HI MAN | -- | 11-2 | 12-6 | 12-6 | -- | 1-6 | -- | -- | 5-7 | |
| 6 | ONE EACH | 10-2 | -- | -- | 9-3 | -- | 4-6 | 6-8 | -- | 5-7 | |
| 7 | HI MAN | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 | Lo |
| 8 | HI MAN | -- | 10-2 | 4-6 | 4-6 | -- | -- | -- | 6-11 | 5-7 | |
| 9 | HI MAN | -- | 10-1 | 6-12 | 6-12 | -- | -- | -- | 6-11 | 5-7 | |
| 10 | ONE EACH | 10-2 | -- | -- | 9-3 | -- | 3-6 | 6-8 | -- | 5-7 | |
| 11 | ONE EACH | 10-12 | -- | -- | 6-12 | 4-6 | -- | -- | 6-9 | 5-7 | |
| | Briefed for Bombing Run | | | | | | | | | | |
| 1 | NOSE OUT | -- | -- | 9-3 | 9-3 | -- | 12-3 | 9-12 | -- | 5-7 | |
| 2 | NOSE OUT | -- | -- | 8-2 | 8-2 | -- | 12-3 | 6-7 | -- | 5-7 | |
| | (Rest of Formation Same as Above) | | | | | | | | | | |

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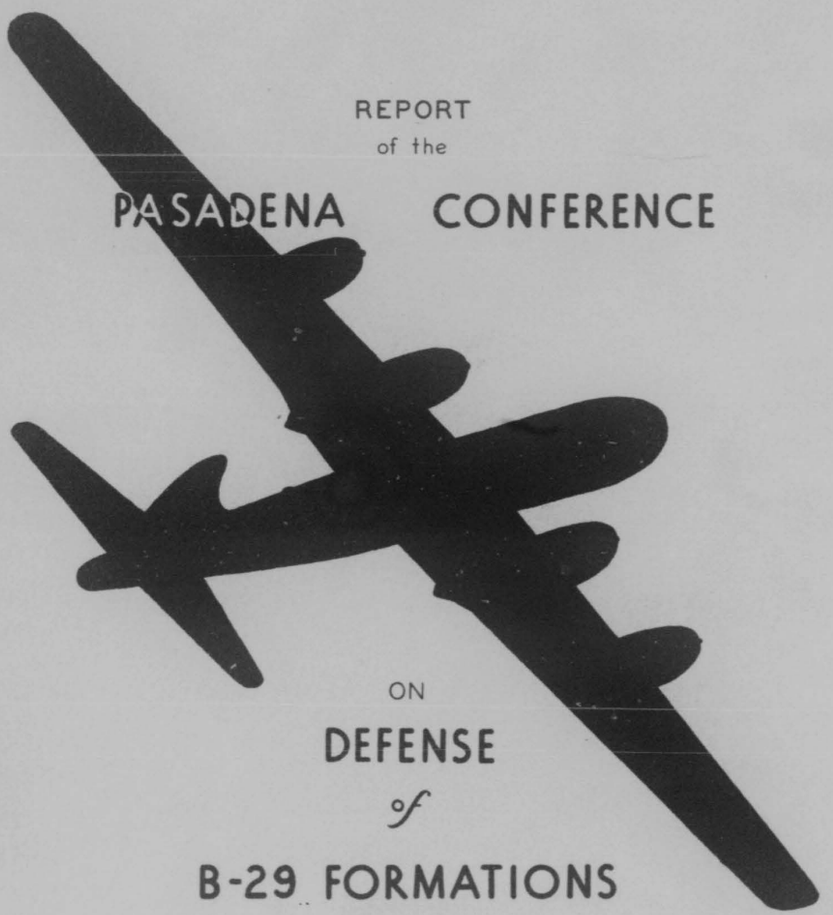
REPORT
of the

# PASADENA CONFERENCE



ON

# DEFENSE
*of*
# B-29 FORMATIONS

Held at
MOUNT WILSON OBSERVATORY
15-26 February 1945

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# REPORT OF THE PASADENA CONFERENCE ON DEFENSE OF B-29 FORMATIONS

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REPORT OF THE PASADENA CONFERENCE
ON
DEFENSE OF B-29 FORMATIONS

Held at Mount Wilson Observatory
15-26 February 1945

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2. Members of the Pasadena Conference.

3. Diagrams of the Standard 12-Plane B-29 Formation Prescribed by XX Bomber Command Tactical Doctrine.

4. Turret Assignments, Briefed Areas of Search and Fire for the Standard 12-Plane B-29 Formation.

5. Number of Guns Bearing at Various Points of the Sky, Standard 12-Plane B-29 Formation.

6. Intensity of Firepower which can be Directed to Various Points of the Sky, Standard 12-Plane B-29 Formation.

7. Photograph of Light-(Fire) Intensity around the Standard 12-Plane B-29 Formation, with B-29 Shadows Showing the Possible Cases of Own Formation Damage.

8. Index of Fighter Hits per Pass on a B-29.

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12. Analysis of B-29's Lost to Enemy Action.

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# REPORT OF THE PASADENA CONFERENCE ON DEFENSE OF THE B-29 FORMATIONS

## I. PURPOSE OF THE CONFERENCE.

(1) Concurrent with the development and expansion of B-29 operations a number of military and scientific establishments have addressed themselves to various aspects of the problems connected with the defense of the B-29. Even while tactical doctrines were being evolved from the lessons of combat continued efforts have been made to evaluate our combat experience, to re-study our own and enemy tactics, to assess the accuracy of our gunnery system, to measure the fire power presented by various formations, spacings, stackings, and assignments of turrets, and to employ every conceivable device to improve our gunnery training. Most of these efforts have been conducted separately by different groups, each intent on its own contribution to the ultimate goal of improving B-29 defense.

(2) The Twentieth Air Force believed that valuable results would come from coordinating the information and experience of the different groups concerned with the problem by asking them jointly to study the current tactical doctrine of formation defense and to make recommendations as to means by which B-29 formations could most successfully be protected. (See Inclosure 1 for Memorandum from Chief of Staff, Twentieth Air Force to members of the Pasadena Conference.)

(3) Accordingly, on 15 February 1945, there convened representatives of Twentieth Air Force, Second Air Force, Training Command, Army Air Forces Board, NDRC Project AC-92, and Mount Wilson Observatory. (See Inclosure 2 for list of members of the Conference.) Thereafter for twelve successive days meetings were held to exchange relevant information and to reach joint conclusions as to recommendations suitable for immediate consideration by both Combat and Training Air Forces.



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(4) The following document represents the considered judgment of the working members of the Conference as to means by which B-29 formations could best be defended under present circumstances. It is primarily addressed to field commanders to help them in their immediate problems of combating the enemy with the men and equipment now available to them. Secondarily, it includes recommendations to the Training Air Forces as to means of implementing the program for the field.

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II. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

A. The principal conclusions of the Conference follow:

1. Combat experience bears out the test data and theoretical conclusions that B-29 formations are most vulnerable to fighter attacks which originate from the nose level and nose high areas.

2. Measurements of the fire power of the standard 12-plane formation with defense as prescribed by XX Bomber Command Tactical Doctrine, suggest that we can afford to reduce beam defense, tail defense, particularly tail high, and nose low defense if by so doing, nose level and nose high defense is increased.

3. Massed defense against enemy attacks from a particular direction by free exchange of turrets offers an attractive possibility when crew coordination is well advanced, but it is believed this would lead to chaotic confusion if attempted at present.

4. After review of the major considerations which should govern the establishment of a practical and effective doctrine of formation defense, the Conference is agreed that the XX Bomber Command Tactical Doctrine is soundly and expertly conceived in all major respects. In view of recent combat experience, however, it is believed that certain particular improvements could be made to meet the current tactical situation.

B. To this end, the Conference recommends for the consideration of overseas Commanders:

1. The adoption of the Rules for Turret Allocation listed in Section III C, and discussed in Section IV C.

2. The adoption of the Rules for Briefing Areas of Search and Fire Listed in Section III D, and discussed in Section IV C.

3. The restacking of the rear element of the formation as described



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in Section IV D.

4. The maintenance in combat of the tightest formation possible to fly to avoid the sacrifice of formation fire power shown in Section IV E.

5. The application of the Turret Allocation and Briefing Rules to formations of sub-standard numbers as discussed in Section V.

6. The adoption of radius framing as described in Section VI B.

7. The adoption of the techniques of search proposed in Section VI C.

8. The adoption of the practice of firing at tail breakaways as described in Section VI D.

9. The indoctrination of gunners on the points discussed in Section VI E.

10. The expedition of all attempts to solve the problem of improving the accuracy of fire against nose attacks.

C. <u>To provide B-29 gunners capable of most effectively defending the formations which will be flown in combat the Conference recommends for the consideration of Training Command, and Training Air Forces:</u>

1. Crew coordination training as described in Section VII A.

2. Formation gunnery training as described in Section VII B.

3. Implementation of the training program as described in Section VII C.

4. Emphasis on the doctrine of support fire as discussed in Section VII D.

5. The employment of the additional aids to effective formation gunnery described in Section VII E.



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III. THE PROBLEM OF B-29 FORMATION DEFENSE.

A. Present Information Concerning B-29 Formation Defense.

(1) The first attempt to evaluate the fire power of the standard 12-plane B-29 formation was made overseas by the Operations Analysis Section, XX Bomber Command. The only other available objective measurements of the fire power of a formation as a whole, as contrasted with that of the same number of B-29's taken individually are those obtained by the technique developed by NDRC Project AC-92 at Mount Wilson Observatory. The method employed on this project involves the use of scale models of B-29's into which are inserted lights at each gun turret to represent fire power. Each light is carefully shielded in accordance with the sighting and firing limitations inherent in the CFC system, together with additional restrictions on areas of search and fire to which gunners are briefed. Then, with the model planes set up in formation, the intensity of light at any point in space around the formation represents the aggregate fire power which can be brought to bear on that point. Typically 24 measurements were taken in azimuth, equally spaced on either side of the clock angles, and 6 measurements were taken in elevation, at approximately 6°, 17° and 30° above and below the horizon. By averaging pairs of measurements, the resultant figures express the average fire power which can be directed to [illegible] above), [illegible] low (averaging [illegible]

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c. The possibility of own formation damage can also be detected by the use of lights to simulate guns. Each plane in the line of fire of another plane's guns (or lights) will cast a shadow. (Inclosure 7 shows photographs of the aggregate light (fire) intensity around the standard 12-plane formation. Note the shadows of B-29's in the line of fire of friendly guns.)

d. These gun counts and intensity measures serve to provide a quantitative basis for assessing the static fire power which can be brought to bear to defend a formation from an attacker at any point in the sky. While it is recognized that numerous other factors influence the effectiveness of defensive fire, it is believed that static fire power is a basic measure and should first be stated without qualification, without being obscured by too early an introduction of elaborate weighting procedures to allow for other variable factors.

(2) One important set of variables in addition to fire power alone is actual gun accuracy in the B-29 and in the attacking fighters. The Alamogordo--University of New Mexico project of NDRC Project AC-92 undertook to measure the relative accuracy of B-29 gunnery and fighter gunnery as it varies with the clock angles around the bomber. For this purpose single B-29's of the 206th Base Unit were attacked by single B-47's, each plane equipped with camera guns. The film was then analyzed and Inclosures 8 and 9 show some of the principal conclusions.

a. Inclosure 8 shows how the fighter's effectiveness measured in terms of hits per pass varies with the clock angle from which he attacks the bomber. The absolute number of hits as published in the University of New Mexico Interim Report dated 15 November 1944 has been deleted from the diagram and replaced by an index which places an arbitrary value of 100 on attacks from astern. Regardless of the way the data are expressed, they clearly show that the effectiveness of fighter gun fire is at a minimum on beam passes, at a relative maximum on nose passes, and at a much higher maximum on tail passes.

b. Inclosure 9 shows that the B-29's defensive fire has the same general characteristics, with the tail maximum even more pronounced.

c. It must be pointed out that these tests were limited to engagements between single bombers and single fighters, so that they cannot be counted as indicative of the relative effectiveness of mutual fire support in a bomber formation against coordinated fighter attacks. However, they offer a valuable measure of the combined influence on gunnery accuracy of such factors as computer lag, closing speeds, angles off, tracking rates, total lead, and "Gee" loadings on the fighter.

(3) Combat experience in both the XX and XXI Bomber Commands makes it clear that the Jap has chosen to attack from the nose where the risk to the fighter is relatively low and where the fighter's relative advantage over



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the bomber is greatest. Operations Analysis studies conducted in Hq. Twentieth Air Force and Hq. Bomber Command,* together with A-2 and Statistical Control studies conducted at all echelons, come to similar conclusions as to the facts concerning our own and Japanese tactics and effectiveness.

a. Tallies of the clock directions and elevations from which the Japanese have attacked formations of both the XX and XXI Bomber Commands, will be found in Inclosure 10. These tallies reveal a number of significant facts:

1. Japanese fighters, whether they are protecting Tokyo and Nagoya from XXI Bomber Command B-29's, or such targets as Omura, Mukden, Rangoon and Singapore from XX Bomber Command B-29's, generally employ similar tactics. In each case their choice as to clock directions from which to attack is substantially the same. Against the XX Bomber Command which typically flew at lower altitudes, high attacks greatly predominated, while against the XXI Bomber Command which generally bombed from higher altitudes, level and high attacks were most frequent.

2. Two-thirds of all attacks came from within the forward zone of 10-2 o'clock and by far the greatest proportion of these were from high and level,--within the area which can be covered by B-29 upper turrets.

3. Attacks from both beams and the tail, from 9 o'clock to 6 and from 3 to 6, accounted for only one-third of all attacks, and the preponderance of these were from 5, 6, 7, high level and low,--well within the coverage of B-29 tail guns.

b. Analysis of our claims against enemy fighters, with reference to the direction from which the attack originated (See Inclosure 11) suggests, as might be expected, that:

1. B-29 gunner accuracy (as measured by claims) increases low and toward the tail.

2. B-29 gunners make few claims where closing speeds are high and angles-off are great. However, since the o'clock position of a fighter changes during his pass, and since

* See especially Operations Analysis Section, XX Bomber Command, Report No. 14, "Combat Performance of the Remote Control Turrets of B-29 Aircraft," dated 10 February 1945.



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the combat claims are unclear as to the point on the pass, or the breakaway, when the fighter was hit, accurate conclusions cannot be drawn from the combat experience as presently recorded. Such conclusions as can be drawn give weight to the basic notion that the high nose area of B-29 formations is relatively weakly protected, the tail zone area is strongly protected, and that the Japanese apparently take advantage of this fact by concentrating their attacks on the nose.

c. Final, and extremely significant evidence of the under-protection of the nose, and of the high forward zones around a B-29 formation is to be found in an analysis of 25 cases in which B-29's were lost to enemy action. A study made in the Operations Analysis Section of the XX Bomber Command (See Inclosure 12 for a summary of this analysis) shows that in every case, except one, of a B-29 lost to an enemy fighter, whether through gunfire, ramming or aerial bombing, the successful fighter attack(s) originated from the forward zone (11-2) and that in 12 out of 14 cases the attack came from high or level.

d. The conclusion seems inescapable:

IN MASSING FIRE POWER TO AFFORD THE STRONGEST DEFENSE OF B-29 FORMATIONS AGAINST JAPANESE FIGHTERS, THE MAXIMUM NUMBER OF GUNS (AND GUNNERS) SHOULD BE CONCENTRATED AGAINST NOSE ATTACKS FROM 10 TO 2 O'CLOCK, ESPECIALLY FROM HIGH AND LEVEL.

(4) The distribution of fire power in the B-29 can be varied by reallocating turrets to gunners, making use of primary and secondary controls. Since there was a question whether turret exchange is practicable and since this question involved the training of gunners, the Gunnery Section, Operations and Training, Second Air Force conducted Project T-21 to study these questions. It was found best to give names to each of the possible combinations of assignments in the airplane. For example, HI MAN RIGHT gives the top gunner both upper turrets, the nose gunner the lower forward, the right blister gunner the lower aft, and the tail gunner the tail. When the command, HI MAN RIGHT, comes over the interphone all turret assignments are thus determined. (See Inclosure 13 for the standard nomenclature of all allocations, as taken from the XX Bomber Command Tactical Doctrine.) The conclusion of 2AF Project T-21 was that turret exchange by central command is feasible and can be accomplished without confusion in a ship flying alone as the fighter commits himself to attack. However, when B-29's are in formation T-21 concluded that the usefulness of turret exchange should be limited to



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turret reallocation upon changing position in formation.

B. Basic Considerations in Defending a B-29 Formation.

(1) In attempting to evaluate the defensibility of any B-29 formation, it is essential that attention be paid to a number of tactical considerations. In addition to the information detailed in the preceding section, much of which is subject to actual measurement, it was necessary for the Conference to consider a number of variable factors which are not subject to precise measurement. In order that the conclusions and recommendations reached by the Conference be properly evaluated, it is necessary to understand that they were based on such considerations. A brief statement of the principal ones follows.

(2) The flyability of a formation is paramount. Although it must be so designed as to provide an effective bomb pattern, maximum fire power defense, and economy of fuel and must compromise these goals with considerations of minimizing risks from flak, air-to-air bombing and ramming, it is imperative that it be capable of being flown as prescribed with comparative ease by average pilots with average present day training. It is unrealistic to base plans and measurements for maximizing defense on an idealized formation if the ideal is seldom or never achieved.

(3) The intensity of the fire power which can be brought to bear in any area of attack is a primary consideration in bomber defense. Because of mechanical and man-made inaccuracies in our gunnery we must rely on a shotgun rather than a rifle effect and place many bullets in the sky in the plane of action of an attacker. The fire power of a formation in any given portion of the sky is affected by the arrangement and spacing of the formation; by the assignment of guns to sight stations; by the briefing of gunners and by the accuracy of fire in that direction. This intensity diminishes with increasing range for several reasons, the principal one being the reduction of bullets per square foot in the bullet pattern. The Mount Wilson measurements of fire power allow for this diminution in intensity by simulating fire power intensities with light intensities which diminish in the same way with range.



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(4) The dependability of the defense is affected by the number of guns and gunners which comprise this total intensity of fire power. By multiplying the number of guns and gunners in any portion of the sky we make certain that a malfunction or a lack of alertness of a gunner does not leave a zone defenseless. An indication of the safety factor of diversification of the defense can be had from a simple count of the number of guns bearing and the number of gunners controlling them.

(5) The possibility of saturation of the defense by coordinated attacks is reduced if a large number of gunners can fire against attacking fighters. However, experience and teamwork as well as alertness will have a greater bearing upon the ability of the enemy to divert the bomber defense.

(6) Own-formation damage must be guarded against. This is accomplished by proper briefing in assignment of turrets and arrangement of the formation. From combat results it is not yet clear how serious a problem this is, but it must be carefully considered in briefing gunners and allocating zones of search and fire. The greatest danger comes from a frontal attack where the leads are such that a friendly aircraft will appear in a gunner's sight only after his guns have fired through it. Although own formation damage is potentially serious on beam fire, there should be little occasion for a gunner to fire laterally through the formation because beam attacks are not dangerous and are infrequently made.

(7) Flexibility without radical rearrangement of the formation or changes in the armament is afforded the B-29 by the possibility of reallocating guns through primary and secondary controls. There are 36 possible combinations of which 12 are named in the XX Bomber Command Tactical Doctrine. The entire flexibility of the system has not been explored to date, but it must be remembered that too great a flexibility would bring about complications in equipment and confusion within the crews. It is believed at present that in a large formation free exchange of turrets would create a chaotic situation.

(8) The selection of targets by the gunner depends upon whether it is best to fire at the most immediately dangerous enemy regardless of the



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chances of hitting him or best to hold fire until he is a target of greatest opportunity. Fortunately, these principles are not in conflict, for gunners instinctively will fire at attackers. It must be remembered that guns and gunners are carried by bombardment aircraft to enable the bomber to destroy targets by bombing and not primarily to destroy enemy aircraft. Therefore, targets of opportunity are to be regarded as a kind of bonus to defense. But, as will be seen, breakaways through the tail cone offer a very substantial bonus of this type.

(9) Altitude and speed sharply affect the characteristics of the fighter attack. At very high altitude the enemy attacks are likely to be limited to one pass per fighter; low attacks are likely to be more prevalent with fighters struggling for altitude. Beam attacks will be more difficult at high altitude and high speed. Maneuverability of fighter and bomber will be reduced and ramming may become more frequent, even though it may be merely accidental. High altitude will force the enemy to confine himself to nose attacks when using present fighters. The speed of the B-29 (TAS = 300 MPH or better) will impose "Gee" restrictions on conventional fighters regardless of their improved speeds. These factors will keep the danger of beam attacks at a minimum. If B-29's fly at lower altitudes they must expect a preponderance of high attacks, and greatly improved performance on the part of Japanese fighters.

(10) The quality of enemy fighters will affect the nature of formation defense. Heavy, high speed fighters with large caliber guns may shift to tail attacks such as the German "Company Front," for the use of large caliber guns demands accurate fire and greater accuracy is gained by tail attacks. Jet fighters will probably introduce more low attacks. Present enemy production is likely to bring better conventional fighters capable of making repeated attacks at high altitudes and higher speeds.

(11) Accuracy of fire from the bomber varies radically with the angle off the nose. The bomber fires more accurately dead ahead and dead astern. Beam firing is inaccurate, but this is comparatively unimportant because beam attacks from fighters are not dangerous. Therefore, reduction



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of fire toward the beams can be effected without serious defensive loss and with gains in reducing the probabilities of own formation damage and in concentrating needed fire power elsewhere. If TAS of 300 MPH can be maintained, weakness of fire power on the beam is not serious. However, if TAS decreases to around 225, a reallocation of zones of search and fire may be needed to strengthen the fire power against beam attacks. Good formation stacking to reduce the danger from relatively inaccurate beam strafing attacks is important even at high speeds. Strafing attacks cannot be dismissed with a target of the size of the B-29, especially if the Jap can line up several bombers at once.

(12) Evasive action against fighters for B-29's in 12 aircraft formations is hardly feasible. Evasive action sufficient to destroy a fighter's accuracy will tend to loosen the formation to such an extent that any hoped for support fire would be lost. If, however, a single B-29 or a small formation, 3 A/C, is subjected to fighter attacks, evasive action should be taken to deflect the fighter's aim and reduce his probabilities of hits. The simple rules of turning away from a nose attack and turning into all others should be remembered.

(13) The looseness of the formation as it affects formations defense is clearly illustrated and discussed in a later section. If formation integrity is not maintained, most support fire is lost and the danger of friendly aircraft damage is greatly increased. If a large formation cannot be flown tightly, better defense will be insured by several small tight formations. A likely training slogan is, "It's better to Struggle than to Straggle."

(14) The danger from ramming is likely and serious. If intentional ramming attacks increase to the point of being a major hazard, the only immediate defense is to loosen the formation to allow for individual evasive action. At present, to guard against such attacks we must concentrate our fire power in the frontal zone from level to high, endeavoring to destroy or deter the enemy before he reaches the formation; and possibly restacking the formation so as to minimize the possibility of a rammed B-29 crashing into



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another. A consolidation of intelligence information on enemy ramming tactics is being prepared in manual form by the AAF Board for distribution.

(15) Present enemy flak is not a serious problem because of the limited number of radar plotting sets available, the high altitude that is being flown, high speed being flown, and the persistent cloud layer over the targets. However, with an increase in radar equipment flak damage will also increase. To avoid this the formation leaders should employ a mild evasive maneuver except on the bomb run. This requires only a few degrees of correction in course every 20 to 30 seconds. These corrections should not be uniform -- for if they are, the enemy will learn the course and is likely to secure hits. From flak studies with the B-17 and B-24 it has been found that the size of the formation is a major factor in reducing flak damage. 12 A/c formation, for instance, has roughly a 50 per cent less probability of being hit than an 18 A/c formation. If the enemy flak increases in accuracy and intensity it may mean that the size of the formation will have to be changed. A flak study of Japanese guns and probabilities of hits on present B-29 formations is being carried out at the AAF Board and the results should be available in a short period of time.

(16) Other formations were not given serious consideration by the Conference except for smaller formations likely to develop from an original twelve through assembly difficulties, abortives, or losses. To take up the design of new formations would be both impractical and beyond the scope of the Conference as described in Inclosure 1.

C. The Principles of Turret Allocation.

(1) The maximum defense for a B-29 formation cannot be accomplished by the simple expedient of making the same allocation of turrets to gunners regardless of the position of their plane in the formation, as is prescribed in the present Tactical Doctrine of the XX Bomber Command. Maximum defense for a formation can only be achieved if each plane's position is used to protect adjacent planes as well as itself, and is made the determinant of its turret allocations. On the other hand, simplicity demands that each plane's



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defensive function be easily understood. For crews to memorize detailed charts of the formation showing turret allocations and briefed areas of search and fire for each gunner in each plane would be unduly complicated, and might cause great difficulty whenever the formation was looser than prescribed or was below standard in number.

(2) From a careful study of the alternatives, there emerged within the conference the conclusion that a set of simple rules should be developed which relate the defensive function of each plane to its position in the formation. These rules should serve to systematize defense, and should be applicable regardless of the number of planes in the formation. It is expected that each Airplane Commander and/or each Pilot could master the rules and apply them to determine his correct turret allocation without reference to prepared charts. For this purpose he would need to know only his position in the element and the position of his element in the formation.

(3) As compared with the present doctrine, it is demonstrable that the proposed rules establish a fire coverage which

a. Provides more gunners to defend against coordinated attacks.

b. Provides greater diversification of defense on the wings.

c. Provides concentration of fire against nose attacks.

d. Insures adequate tail coverage.

e. Can be used by any standard formation of from 1 to 12 planes.

(4) The recommended rules for turret allocation follow:

RULES FOR TURRET ALLOCATION

I. A WING SHIP OR ELEMENT.

| | |
|---|---|
| Definition | A ship or element which lacks support from at least one side. |
| Defensive Function | Wing Function--to provide all around fire support, with emphasis on the outside and the tail. |
| Turret Allocation | ONE EACH, with ring gunner directed to the side or rear and outside blister gunner controlling lower aft turret. |
| Precedence | None. |



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II. A CENTER SHIP OR ELEMENT.

| | |
|---|---|
| Definition | A ship or element which has upper rear quarter and wing support on both sides. |
| Defensive function | Center Function--to provide fore and aft fire, primarily forward. |
| Turret allocation | HI MAN, with ring gunner directed forward. |
| Precedence | Center function takes precedence over wing function. Thus the center ship of a wing element, and the wing ships of a center element all assume the center defensive function and use HI MAN allocation. |

III. A REAR SHIP OR ELEMENT, STACKED LOW.

| | |
|---|---|
| Definition | A ship or element which flies behind another ship or element in such a way as to block the upper forward fire of its own guns. |
| Defensive function | Tail Low Function--to provide lower forward and upper rear protection. |
| Turret allocation | HI MAN with ring gunner directed to the rear. |
| Precedence | Tail Low Function takes precedence over both center and wing functions. Thus wing or center ships of a low rear element must assume tail low defensive function and use HI MAN allocation. |

IV. A REAR SHIP OR ELEMENT STACKED HIGH.

| | |
|---|---|
| Definition | A ship or element which flies behind another ship or element in such a way as to block the lower forward fire of its own guns. |
| Defensive function | Tail High Function--to provide upper forward and lower rear protection. |
| Turret allocation | ONE EACH, with ring gunner directed forward, and blister gunners directed towards the rear. |
| Precedence | Tail High Function takes precedence over center function but not over wing function. Thus center ships of a high rear element must assume tail high defensive function and use ONE EACH allocation with ring gunner briefed forward. However, a wing ship of a high rear element may be assigned wing function if it lacks support from one side. |

V. Immediately before and during the bomb run, the NOSE OUT allocation will be used in lead and deputy lead ships to free the bombardier



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from all responsibility for defense of the formation and enable him to devote his full attention to bombing.

(5) Some of the consequences of the above rules are worth noting.

a. A single ship should assume ONE EACH as if it were a wing ship, since it has no wing support.

b. Each ship in a two ship element should assume ONE EACH as if it were one of two wing ships without a center.

c. In a three ship element the leader should assume the center function using HI MAN forward, with the two wing ships using ONE EACH on opposite wings.

d. In a diamond four ship formation all four defensive functions are represented, with the ship filling in the the diamond using HI MAN or ONE EACH according to whether it is stacked low or high.

e. A nine ship formation is merely an extension of the principles involved in defending a three ship element, with each element's basic defensive function determined by its relative position, and with the tail function taking first precedence over the wing function in establishing the proper turret allocation for each ship.

f. By the same token, a twelve ship formation is merely an extension of the defensive principles involved in allocating turrets in a diamond four ship formation with allocations for individual ships determined by the rules of precedence.

(6) For examples of the application of these rules to B-29 formations, see Inclosures 16, 22, and 28. Inclosure 16 shows the turret allocations and restrictions on areas of search and fire recommended for the 12-plane formation presently prescribed by the XX Bomber Command. Inclosure 22 shows similar information for the formation if the rear element were stacked high instead of low, to increase upper forward fire power. Inclosure 28 shows how these rules would apply to formations of all sizes, with varying stacking, from single ships to 11-ship formations, whether they were built up from single ships or were created by subtracting abortives and losses from the standard formation. It will be noted that the clock angles covered by different gunners will show some variation, since they must be briefed to avoid own formation damage, but the turret allocations are unaffected.

(7) One additional suggestion might be offered. Since it was considered essential to keep the turret allocation rules as simple as possible,



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the entire system was limited to the use of two types of turret allocation: HI MAN and ONE EACH. It is apparent, however, that a certain amount of additional protection could be achieved if the ships assuming the wing function, particularly in the larger formations, employed GANG LOW with the outside blister gunner controlling both lower turrets, instead of the ONE EACH in which the inside blister gunner is typically assigned a relatively limited and ineffective sector to defend. Accordingly, it is recommended, that, where Airplane Commanders prefer, GANG LOW be substituted for ONE EACH in all ships assuming the wing defensive function.

D. The Principles of Briefing.

(1) Even after turrets have been allocated, it is imperative that there be clear definitions of the sectors in which each gunner should search and fire, in order to provide a balanced and effective defense for the formation. Failure to define these sectors, or failure on the part of gunners to follow the briefed limitations of areas of search and fire may lead to the following undesirable results:

a. Gunners may try to search over too wide a sector. In this case their effectiveness will be sharply reduced since all parts of that sector cannot be scanned thoroughly and with sufficient frequency to detect developing attacks.

b. Gunners may concentrate their search on too small a sector. In this case some zones will be left open from which attacks might develop.

c. Gunners not knowing where to search may divide their coverage so that they overlap or underlap. In this case the formation is inadequately protected against sneak or coordinated attacks.

d. Gunners may select sectors of search and fire which will cause them to fire at ships in their own formation. This is an obvious hazard in the cases where the position of a ship in the formation causes its field of fire to be blocked by other ships directly in the line of sight of a gunner. Less obvious, and accordingly more dangerous, are the cases where deflections cause considerable displacement of the bore axis from the line of sight. Towards the beam these deflections attain magnitudes of over 200 mils.

(2) To avoid these difficulties the Conference concluded that there is a need for gunner briefing. Such briefing can be defined as the



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assignment of turrets to gunners and the limitation of their areas of operation with the object of providing maximum protection of the more vulnerable areas and reducing self-inflicted damage in the formation to a minimum. Each gunner should be assigned an area of search and fire within which it is his responsibility to detect and destroy enemy interception. These areas should be 180° in azimuth or less to prevent undue eye fatigue and insure efficient and frequent search. Areas can safely be limited in this way since B-29's flying in formation with properly briefed gunners can obtain adequate protection of their less vulnerable areas by means of the gunfire and position support of adjacent ships.

(3) At the same time, formation flying introduces an additional hazard: own formation damage, which can only be eliminated by the exercise of care on the part of gunners. The conclusions of the University of New Mexico, Alamagordo Project of NDRC Project AC-92 suggest that fire from both fighter and bomber is extremely inaccurate in the beam areas (see Inclosures 8 and 9). Since friendly airplanes normally occupy these areas in formation flying, there is reason to support the recommendation that fire be held to a minimum here. With this concept in mind, briefing should be designed to concentrate a maximum of fire power in the forward and rear areas rather than on the beam. Further, in reducing the hazards of own formation damage, the following points merit consideration:

a. Normally the direction of deflection of the gun from the sight line will be towards the tail of the bomber. Hence every gunner must break off firing at a nose pass when his sight line is still about one clock angle (30°) ahead of a friendly bomber in the beam area.

b. On the other hand, when a gunner briefed to the rear picks up a target on the beam and just astern of a friendly ship, the normal lead will be away from the B-29 and will not in itself be a hazard. However, there is a very real danger that as the sight and guns are slewed onto the target a large deflection in the wrong direction will be introduced and may still be present when the gunner opens fire. This danger will be reduced, if during periods when interception is expected, the guns are carried pointed in the direction from which attacks will probably originate. But sleeving will still occur occasionally when the gunner has tracked one target toward the tail and then picks up another one near the beam.

If the gunner tracks each new target for one or two seconds before opening fire, as he should do in any case,



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the false lead caused by slewing will cause no danger. But since the gunner in his eagerness may not follow this rule, it is advisable to allow an interval of about half a clock angle (15°) between a friendly ship on the beam and an area of search and fire astern of it.

(4) In accordance with these principles, the Conference recommends the adoption of the following simple rules to govern the briefing of gunners as to their proper areas of search and fire.

RULES FOR BRIEFING AREAS OF SEARCH AND FIRE

I. Nose gunners normally search and fire from 10 to 2 o'clock.

II. Ring gunners normally search and fire over a 180° sector which is centered as directed in the Turret Allocation Rules, but which may be varied from that center in accordance with IV.

III. Blister gunners normally search and fire in the entire area in which they have visibility, including the lower forward area under the wings to within 30° of the nose. Their maximum sector is thus 150°.

IV. All gunners will further restrict or modify their normal areas of search and fire as conditions require, to avoid danger of damage to friendly ships.

a. When an area of search and fire is directly forward of another B-29, so that the normal direction of tracking is toward it, the azimuth limit of the area will be set at least one clock angle ahead of the friendly ship.

b. When an area of search and fire is directly aft of another B-29, so that the normal direction of tracking is away from it, the azimuth limit of the area will be set at least one half clock angle astern of the friendly ship.

c. As soon as turret allocations are announced, each gunner will determine the safe limits for his area of search and fire. He will be continually alert, both during action and between attacks, for changes in the positions of any B-29's which might require further restriction of his fire.

(5) These briefing rules, together with the rules of turret allocation outlined in the preceding section, have been applied to 36 possible formations varying in size from 1 to 12 planes. (See Inclosures 16, 22, and 28.)



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IV. EVALUATION OF THE 12-PLANE FORMATION DEFENSE PRESCRIBED BY XX BOMBER COMMAND.

A. The Present Tactical Doctrine.

(1) The XX Bomber Command Tactical Doctrine covering formation defense (See Inclosures 3, 4, 13 and 14) was studied in detail by the Conference. It gives every indication of having been carefully and expertly developed, with due regard for the principal tactical considerations enumerated in III B of this report. In general philosophy it agrees well with the conclusions of the Conference in that it provides for support fire, establishes an initial allocation of turrets to gunners and provides briefed restrictions on areas of search and fire to reduce own formation damage. And the formation itself is well designed to provide an effective and balanced defense.

(2) In treating support fire the doctrine allows firing against fighters in the "overtake", "in position" or "attack" phases. It discourages firing against fighters who have made a definite breakaway as being not dangerous or potential targets. But it does not restrict the attacking phase to exclude attacks against another bomber in the formation. To do so would destroy the concept of support fire.

(3) Present doctrine establishes the initial turret allocation throughout the formation to be HI MAN. The reason for the use of HI MAN is that the nose gunner cannot as effectively use his sight in the upper hemisphere (due to body restrictions, etc.) as the top gunner can. It establishes the use of NOSE CUT for the lead and deputy lead ships on the bomb run to free the bombardier to operate his bomb sight.

(4) It provides a briefing and turret allocation schedule for the standard 12-plane formation. (See Inclosure 4.) The briefing is intended both to eliminate the probability of own formation damage and to direct the fire where it is believed to be needed.

B. Potential Weaknesses of the 12-Plane Formation as Presently Prescribed.

(1) Despite the fundamental agreement of the Conference with the



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general plan of formation defense developed in the XX Bomber Command Tactical Doctrine, careful analysis of the Doctrine indicates several respects in which it might be improved. In the judgment of the Conference the following points merit reconsideration:

(2) Self-inflicted damage in the present procedure. The Notes in Inclosure 4 and the details listed in Inclosure 15 indicate the instances in which a B-29 comes into the search area of a gunner of another B-29. Present doctrine is not completely consistent in distinguishing between search areas, fire areas and search and fire areas. Assuming that the briefing restrictions are interpreted to refer to search and fire areas (and realistically it must be expected that a gunner will fire if he can at any fighter in his area of search), the situations tabulated are serious. Some of them may also be recognized in the form of shadows of B-29's appearing in Inclosure 7. The gunfire of a B-29 turret is not accurate enough to justify jeopardizing another B-29 with it on the chance that it may bring down a Jap fighter who is a small target far away. Careless fire has a much better chance of bringing down a big, valuable, close looming B-29 with eleven Americans than it has of bagging a small, cheap Jap with his not too accurate guns who is far away. It still takes real precision gunnery to shoot down a fighter, even by concentrating much gunfire in his vicinity. (On the other hand, there are situations where search areas should properly extend beyond fire areas. For example, the blister gunners can and should search the upper hemisphere on the beam and the tail gunner should search to both sides well outside of his limited cone of fire. Perhaps these pure search areas should be studied, for it will not hurt a B-29 to look at it, but the present report is concerned with search and fire areas for simplicity and definiteness.)

(3) Lack of diversification of the upper hemisphere defense is a defect with the universal HI MAN allocation. Its use was specified because the nose gunner has a rather poor sight (on a non-rigid pantagraph arm) and because body restrictions in the upper hemisphere limit his effectiveness with it. Furthermore the top gunner is usually a better trained gunner than the bombardier. These are all good reasons. On the other hand the planes in formation which have little support, that is the ones with wing function, need more than a single gunner in the upper hemisphere where the majority of



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the attacks originate. In the critical area of level and slightly high forward the nose gunner's position is not too cramped while the top gunner cannot see at all. (Note the relatively small number of guns bearing at 11, 12 and 1 o'clock level, as shown in the gun counts in Inclosure 5. These are small because the ring gunner, who is supposed to give this support, has his vision and his guns blocked near the horizon.) By the time the attack has passed to such an angle-off above that the nose gunner is severely cramped, the tracking rates may be expected to be so high that the top gunner cannot shoot accurately either. Also, in the exposed wing positions the top gunner is needed to defend against the high five or seven o'clock attacks which are dangerous because of the high accuracy of the fighter attacks from these directions. Hence the top gunner in these situations should be directed towards the tail. If HI MAN is used this leaves the high exposed wing ships relatively undefended against high nose attacks. In general the present briefing provides too few gunners to defend against coordinated attacks developing as repeated high nose attacks or combined high nose and high tail attacks.

(4) The covering of the upper forward guns of element C by element A may not be desirable. When element C is stacked low, fire power in the low forward area is strengthened at the expense of the high forward area which is currently most urgent. (See Section III A (3) of this report.) This shows up in the fire power intensities (Inclosure 6) and the gun counts (Inclosure 5) of the present 12-plane formation as currently briefed.

(5) The position of C element low behind A element places C element in danger from the bombs and brass of A element. Furthermore an incident has already occurred in which a rammed plane from A element fell and took with it a plane from E element. If C element can be flown high instead of low behind A it will uncover the top guns of C to defend against nose high attacks, it will protect C from falling brass, bombs and even B-29's, it will get C out of the downwash of A element and it will reduce the Jap chances of aligning several B-29's on high nose strafing attacks.

(6) The fire intensity measurements (Inclosure 6) and the gun counts (Inclosure 5) for the present formation show rather more fire power



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on the beam and tail and less on the nose level and high areas than would be desirable in view of present Japanese fighter tactics and capabilities outlined in III A (3) of this report. A balancing of our defensive fire to maximize the protection of our most vulnerable areas should be a prime consideration in turret allocation and briefing.

C. Recommended Reallocation of Turrets and Rebriefing of Areas of Search and Fire for the Present Formation.

The following paragraphs propose a turret reallocation and rebriefing of the present twelve plane formation. The proposed allocation and briefing follow the general principles enumerated in Section III C and D of this report which recognize the danger and inaccuracy of beam fire, the need for concentration against nose high attacks and the better tail defense of exposed planes in the formation. Inclosure 16 shows the new allocations and briefing and Inclosure 17 indicates the extent of the changes it involves in the present briefing.

(1) The only planes receiving a changed turret allocation are number three in D element and numbers two and three in B element. All others have HI MAN, although with left or right phases which do not always agree with the present allocation.

a. The three planes requiring reallocation appear in the chart in Inclosure 16 as having black sectors for the upper forward turret in the nose gunner's series. They all have wing ship defensive function as described in Section III C. They are exposed to attacks throughout most of the upper hemisphere and have little support from the rest of the formation, particularly if the formation is not being flown to the prescribed tightness. ONE EACH is prescribed for them, Right for right wing elements and Left for left wing elements.

b. Number two in D element has both wing and rear ship defensive functions, the latter having precedence. This is the lowest plane in the formation and the HI MAN allocation is most suitable. This plane and all of C element have the rear element function and with HI MAN allocations directed to the rear they give the formation a strong concentration of fire power in the high rear region. All of the planes in A element and the number one planes of B and D elements take HI MAN forward as in the present briefing.

c. The alternative allocation of GANG LOW for ships assuming the wing defensive function suggested in Section III C (6) will allow B2 and B3 to take GANG LOW RIGHT and D3 to take GANG LOW LEFT. This increases the defense against beam strafing attacks which can do damage despite their inaccuracy because they can line up the formation from the beam.



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(2) The proposed rebriefing of the present 12-plane formation, with the reallocation of turrets proposed in the preceding paragraphs, is based upon the direct application of the briefing rules outlined in III D of this report. (See Inclosure 16.) It is designed to eliminate every case in which a B-29 would be likely to come into the area of search and fire of another, even while providing the maximum fire power against all zones from which attacks may be expected. For the sake of simplicity, and on the assumption that greater precision could not be expected of gunners, all angular restrictions are stated to the nearest clock angle. It will be noted that:

a. Turrets controlled from the nose and covering the most vulnerable 10-2 area normally are limited to a 120° sector, but the proximity of other ships causes additional restrictions of one clock angle for ships A-2, B-1, B-2, C-2, C-3 all of which fire from 11-2, and for ship D-3 which fires from 10-1.

b. Ring gunners take a 180° sector in all cases except where their guns are blocked by the presence of other ships. Such restrictions can be found on ships C-1, C-2, D-1 and D-2.

c. Blisters take a 150° sector in most cases, but require restrictions on ships A-1, A-3, B-1, B-2, B-3, and D-3. If the GANG LOW alternative were adopted by ships B-2, B-3, and D-3 which assume the wing defensive function, these restrictions would be largely eliminated.

(3) Measurements of the fire power of the formation thus rebriefed will be found in Inclosure 18. It will be noted that there is an apparent net reduction both in the number of guns bearing and in the intensity of fire which can be directed to many areas. However, a close study of the differences between this proposed briefing and the present briefing will reveal that:

a. The reductions in fire power have come from the least effective areas of fire, from the beam and where angles-off are so great and leads so high that no accurate shooting can be expected.

b. Most of these reductions have come from restrictions necessary to avoid own formation damage. The Conference feels that there is dubious defensive value to gunfire that passes through our own ships before hitting the enemy.

c. Other reductions originate from the effort to restrict gunners' areas of search and fire to limited sectors, not so large that his efficiency throughout the sector is impaired.

d. In the nose and tail areas where Japanese fighter attacks



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are most frequent, and most likely to be lethal, such reductions are not made. To the contrary, from 12 to 17 guns are added to the protection of the nose level area, from 1 to 8 guns are added to tail level and high protection, and some guns are added to level defense at every clock angle except 10 o'clock. The only significant loss in fire power occasioned by this briefing is at 1 o'clock high, where the total number of guns bearing is reduced from 32 to 21.

e. Finally, the proposed briefing adds 2 extra gunners defending the forward and rear zones, because of the ONE EACH turret allocations, which is of strong defensive value, particularly against coordinated attacks.

D. Proposed Restacking of the Present Formation.

(1) Although the members of the Conference hesitate to propose any alteration in the basic doctrine according to which the standard 12-plane stagger is flown, they feel that they would be remiss if they failed to point out the strong defensive advantages which would accrue from a single change:

IF THE REAR ELEMENT (C) COULD BE FLOWN STACKED HIGH INSTEAD OF LOW AS AT PRESENT A SUBSTANTIAL ADDITION WOULD BE MADE TO OUR DEFENSE AGAINST THE VERY ATTACKS WHICH GIVE US THE MOST TROUBLE.

(2) It was apparent to the Conference that, since single ships and 3-plane elements frequently tack on to a high rear position behind and above a lead element, it is not impossible to keep formation from that position. However, it was not clear that reversing the altitudes occupied by the center (A) and rear (C) elements would be feasible in a 12-plane formation because of the difficulties it might create for the high wing element (B).

(3) To determine the feasibility of flying the full 12 planes with the desired restacking, the Second Air Force was requested to test the proposed change on a training mission. Accordingly, on 4 March 1945, in conjunction with its regular Training, the 231st Base Unit at Alamogordo Army Air Field flew a 7 hour mission of which 4 hours were spent flying in 12-plane formations at 190 IAS at 20,000 feet altitude. On this mission both the standard formation prescribed by XX Bomber Command Tactical Doctrine, and the restacked formation were flown. Fighter attacks were made against the formation, and a camera ship took both still and motion pictures of the



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formation. After the mission, a pilots' critique was held to discuss the results of the test. Two members of the Conference flew on this mission as observers, and attended the critique.

(4) A fuller report on this test is available at Second Air Force, and motion pictures taken in flight are being prepared for later distribution. However, from the pilots' critique, and preliminary analysis of the films the following conclusions can be drawn.

a. For all practical purposes the two formations are about equally feasible to fly, but neither the standard nor the restacked version was consistently flown as tightly as prescribed.

b. On the restacked formation no difficulties were encountered by the low (D) element nor the center (A) element. It was recommended, however, that to preserve the integrity of the formation it is particularly important for plane A-2 to fly tight.

c. The rear element (C) cannot safely fly nose to tail of the wing ship of A element. It was recommended that the lead ship in C element should fly one plane length (100 feet) behind to obtain good vision in guiding on the leader of A element. Both the Airplane Commander and the Pilot can then fly the ship with ease.

d. The high element (B) should fly one half wing span (75 feet) farther to the outside, both to obtain better vision and to reduce the risks of collision between ships B-3 and C-2. This element can only be flown by the Airplane Commander who guides on the leader of C element. It was suggested that the formation might be flown more easily and safely if ship B-3 were eliminated and the formation were flown as 11 planes. (See Inclosure 28 for a diagram of this formation, designated as "11-plane C high 2B D.")

e. It was further recommended that the Airplane Commander in each ship should sit on the side from which that ship is most easily guided.

Inclosure 20 shows a diagram of the formation as it would appear if these pilots' recommendations were adopted, and Inclosure 21 shows some photographs of the restacked formation as they actually flew it. A comparison with the standard formation shows that if each were flown at the maximum tightness, the restacked formation would have a 25 per cent increase in its length (from 400 to 500 ft.) and a 6 per cent increase in its breadth (from 1275 to 1350 ft.). Since it is unrealistic to assume that formations are flown in combat as tightly as prescribed, it is believed that the difference is more apparent than real. At any rate the sacrifice in fire



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effectiveness which would result from this small amount of loosening is offset many times over by the defensive advantages of restacking.

(5) If overseas Commanders should accept the Conference suggestion to fly the formation with the rear element high instead of low, the following advantages can be anticipated:

a. A very great increase in the defense against nose high and level attacks since the upper turrets of the rear element will be uncovered. This principle is best illustrated by reference to the briefing diagrams (Inclosure 28) for the 6-plane formations consisting of two elements stacked high and low. With the rear element low, 3 gunners and 4 turrets can fire at high nose attacks; with the rear element high, 8 gunners and 10 turrets can be briefed to defend this area. Similar gains are apparent when two wing elements are added to these six planes to make the standard 12-plane formation. (See Inclosure 29.) With this switch, nose low and tail high protection is necessarily somewhat reduced, but fire power elsewhere is substantially increased and, most important, the overall distribution of fire power from all turrets, including blister controls and tail guns, counters more closely the relative danger from the various areas.

b. Dangers from ramming will be reduced. In the event that a plane in the lead element is rammed, or even if it goes out of control from other causes, it will be much less likely to take another B-29 with it as it leaves the formation.

c. Dangers from falling bombs or brass will be reduced since they will fall clear from the lead element.

d. Wing wash will be reduced. While the present stacking with 50-foot intervals in altitude should avoid all prop wash, which goes fairly directly to the rear, it probably cannot avoid the wing wash which moves sharply downward.

(6) To provide for the possibility that this restacked formation is adopted, the Conference has prepared and presents as Inclosures details of the recommended briefing of the proposed formation (Inclosure 22), and measurements of its fire power (Inclosure 23).

E. <u>The Cost of Flying a Loose Formation</u>.

(1) The preceding analysis of the 12-plane formation as regards both the assessment of the effectiveness of its fire power, and the development of desirable principles of turret allocation and gunners briefing, has been based on the assumption that the formation is flown tightly, with



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interplane spacings identical with those prescribed in the XX Bomber Command Tactical Doctrine and shown in Inclosure 3.

(2) The lessons learned from combat experience and from flying training clearly demonstrate that these ideal spacings are seldom realized. Bomber formations are typically flown much more loosely than prescribed. The following discussion, therefore, is designed to serve two purposes:

a. To recognize the fact that the formation may actually be much less tight than prescribed and to indicate the influence which this will have on the effectiveness of support fire power and on the prescribed briefings.

b. By showing the sacrifice of potential defensive strength and the additional hazards of own formation damage, to provide a strong incentive to formation leaders to keep their formations as tight as possible, thus improving their bomb patterns.

(3) The loss of mutual fire support which results from loosening the formation was studied in some detail by the Conference. Its principal conclusions can be summarized as follows:

a. When the length of the formation is doubled, so that the distance between the nose of the lead ship and the nose of the six wing ships of the wing and rear elements becomes 600 feet instead of the 300 feet presently prescribed, but if the breadth and height of the formation remains the same, the mere effect of incressed range on bullet dispersion will reduce the intensity of their forward fire power protecting the lead ship by 23 per cent at 600 yd. range from the lead ship and by 36 per cent at 300 yd. range. If the length is trebled so that the rear ships are 900 feet back, this forward protection is reduced by 40 per cent at 600 yd. range and 56 per cent at 300 yd. range. (Inclosure 24 shows the calculations on which these figures are based.) By the same token, protection from tail attacks is materially decreased as the length of the formation increases. (See Inclosure 25 for an illustration of the loss of tail protection for a single element when the wing ships fall behind.)

b. When the breadth of the formation increases, other dimensions remaining the same, a number of factors combine to reduce the effectiveness of support fire.

1. There will be a slight decrease in the intensity of forward fire power because of the increased range at which wing ships must try to provide support fire.

2. There will be a greater decrease in beam protection because of this range factor.

3. There will be risk of serious decrease in the effectiveness of tail protection because fewer tail cones of fire will overlap. (See Inclosure 25.)



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4. There will be a sharp decrease in accuracy of support fire in the nose and tail areas because the supporting gunners must fire at increasingly high angles which require higher rates of tracking and more time for the computer to provide the proper deflection. (See Inclosure 26 for an illustration of this problem which is particularly acute on nose attacks.)

c. No change in the overall height of the formation is likely to be made which is large enough to have any appreciable effect on the intensity of support fire.

d. When the length and breadth of a formation are both increased, height remaining the same, the net decrease in the effectiveness of support fire will tend to be the product of the decreases separately caused by the loosening of each dimension of the formation. Thus if looseness in breadth alone reduces effectiveness to 70 per cent and looseness in length reduces effectiveness to 60 per cent, the support effectiveness remaining will be .60 x .70 or 42 per cent of the fire power of a tight formation.

e. If each dimension is doubled so that instead of being 1125 feet wide, 300 feet long and 550 feet high measured from nose to nose, the respective dimensions are 2250 x 600 x 1100, the reduction in fire power intensity can be simply measured by the techniques developed at Mount Wilson Observatory. The results of these measures, at a range of 600 yards, for each clock direction, high, level, and low, will be found in Inclosure 27. In interpreting these figures, it must be remembered that they merely show the effect of increased range on the effectiveness of fire power. The reductions in accuracy which come from increased angles-off, etc., mean that these figures understate the total cost of flying a loose formation. It is worthy of note that these figures show little relative reduction in the fire power intensity of the directly frontal area. The shape of the formation, coming to a point at the front, means that overall increases in dimensions have least effect here.

(4) In addition to the above mentioned reductions in the density and accuracy of support fire, a serious additional sacrifice is involved in flying a loose formation: <u>There is a strong tendency for B-29's in loose formations to block each others' areas of search and fire</u>. This either reduces the areas in which support fire can be directed, or increases the dangers of own formation damage. The circumstances under which these dangers arise are summarized below.

a. As the formation increases in length, or as single stragglers fall back in trail, they come into the zone of fire of the tail guns of ships ahead of them. (See Inclosure 25.) Moreover, reference to the diagrams of briefed areas of search and fire in Inclosure 28 indicates many cases in which the straggling of one ship will necessitate the reduction of the azimuth limits of ring or blister gunners on another ship. There are also frequent cases in which the areas of fire of the straggler itself must be reduced. This is particularly true for the forward fire of rear ships.



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b. As the formation increases in bresdth, or as individual B-29's spread out to the side, the relative angles in elevation change from ship to ship. In a tight formation the 50 foot stacking intervals provide clearance even for the 5° overlap beyond horizontal of upper and lower turrets. As it loosens in breadth, however, there is a tendency for low wing ships to come into the coverage of upper forward turrets and for high wing ships to come into the area covered by lower turrets. (For instance, in the standard 12-plane formation briefed as shown in Inclosure 4, an increase in breadth brings plane D-3 into the field of fire of the upper turrets of C-3, and brings B-2 into the zone covered by the lower turrets of A-2.)

c. As the formation increases in altitude, no difficulties with own formation damage need be anticipated, but decreases in altitude will cause similar problems as increases in breadth since it will uncover the 5° overlaps of upper and lower turrets.

d. If the formation spreads in breadth and length simultaneously, altitude remaining the same, the blocks of gunfire caused by separate increases in a single dimension will tend to be cancelled out, with angles remaining the same, the only exception is that the failure to increase altitudes will produce a flatter formation, with the same dangers as arise in the case of an increase in breadth or a decrease in height.

e. If the formation increases equally in all dimensions, then the dangers of own formation damage or blocked areas of fire will be no more than in the original formation. The effects of range, mentioned above, represent the disadvantage in this case.

(5) The preceding discussion related to the sacrifices involved in moderate loosening of the formation. It must be pointed out that if these dimensions become increased beyond very reasonable amounts, not only is fire support lost, but also position support. With extra flanks exposed, the formation is open to internal attacks, including attacks which fly through the formation. If the integrity of the formation is lost to this extent by excessive looseness, it is probably better to break up into two or more separate tight formations than to continue in a loose aggregation.

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V. THE PROBLEM OF DEFENDING FORMATIONS OF FEWER THAN 12 AIRCRAFT.

A. The Need for a Tactical Doctrine Covering all Cases Likely to Occur in Combat.

(1) In the Twentieth Air Force the Standard Formation for bombing and for defense is the 12-plane stagger, which has been analysed at length in preceding sections of this report. A realistic view of the circumstances of combat operations, however, compels the Conference to recognize that all too frequently this standard is not fully maintained. IT MUST BE EXPECTED THAT MUCH OF OUR BOMBING AND DEFENSE OVER ENEMY TERRITORY WILL BE CONDUCTED BY FORMATIONS OF FEWER THAN 12 SHIPS. Any tally of the actual size of the bombing formations on recent missions will demonstrate this fact.

(2) Smaller formations will occur frequently because:

a. Difficulties of maintenance and assembly are such that planes will often take off expecting to be part of a 12-plane formation, which will turn out to be somewhat smaller, but which nevertheless proceeds to the target.

b. Abortives and combat losses may reduce the size of a formation which assembled as 12 ships, but which thereafter continues the mission as a smaller number.

(3) In either case, it is necessary for the system of formation defense to be adjustable to the non-standard situation. Whether the formation is built up by the successive addition of elements and planes, but fails to reach a total of 12, or whether it starts as 12, but finds its ranks depleted, there must be an applicable tactical doctrine for its defense. The rules of turret allocation and briefing developed by the Conference with respect to the 12-plane formation were devised with this problem in mind.

B. Briefing for Formations Smaller than 12.

(1) Inclosure 28 shows the briefing which would result from the application of these rules to a number of formations of different sizes. This briefing has not been worked out for every combination and permutation of 1-12 aircraft which might result from difficulties with assembly, abortives,



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of losses en route, but it is hoped that representative types of all the major variations are included. All formations have been drawn stacked high to the right. If they should be flown stacked high to the left, turret allocations and briefing must be adjusted accordingly. As in the case of the briefings developed for the 12-plane formations, the turret allocations are determined by the plane's position in its element, and the position of its element in the formation; and the limitations on areas of search and fire, shown to the nearest clock angle, are dictated by necessity for avoiding own formation damage. (The rules for precedence of the various Defensive Functions sometimes require an element of judgment in their application. The assignment adopted in several cases is not the most direct. These exceptions are enumerated in Inclosure 28.) A single man in each ship should be held responsible for knowing the turret allocation and briefing rules, and directing the gunners accordingly. It is believed from his application of these rules alone, without reference to any diagrams, the resulting formation defense would closely correspond to that shown in the diagrams. However, the possibility might be investigated by overseas Commands of reproducing such parts of Inclosure 28 as seem most relevant, and assigning the Pilot the task of carrying them, determining his position in formation and briefing his gunners accordingly. The Conference suggests that no offense against security would be involved in taking these diagrams and tables into the air since they show the maximum defense against the worst the Jap can do. Any readjustment of his tactics to exploit his knowledge of our defensive plan would lead him to choose attacks which are less effective than the ones he is now using.

(2) Study of the details of these briefings reveals several points worthy of mention:

a. In the diagrams in Inclosure 28 ONE EACH allocation can be recognized by the black field of the upper forward turret in the nose gunner's chart. Whether it is the right or left phase can be determined from the blister gunner's chart by noting on what side the lower aft turret operates.

b. As in the case of the 12-plane formation, GANG LOW would generally improve the wing function defense if a third allocation is to be permitted.

c. The proportion of ONE EACH allocations decreases and of HI MAN increases as the formation becomes larger. This is consistent with the requirement of greater vigilance and large search areas for each gunner in the smaller formations. It is also consistent with the desire to put more fire power forward and high in the larger formations where it is possible.



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d. The most striking difference between formation fire power and individual ship fire power is in the strength of the tail turrets when they are combined. Whereas the tail turret of a single ship needs help from the upper aft turret in a single ship, it does not behind the center of a large formation. Even with the top gunners briefed in other directions, the tail cone will have the greatest fire power of any portion of the sky.

C. The Relative Fire Power of Various Small Formations.

(1) Inclosure 29 shows the number of guns which each of these smaller formations can direct to various parts of the sky. From this the relative defensibility of each can be roughly assessed.

(2) Since it is not the purpose of this report to make suggestions for the use of other than the 12-plane formation, no conclusions are presented at this time. It is worthy of note, however, that:

a. Some of these formations flown tightly will offer a stronger defense than a loosely flown 12.

b. In the event that a sub-standard number is flying together as a result of abortives or losses, there is little opportunity to readjust the defense except to fill in from the rear and keep the front ranks intact.

c. In the event that only a small number is able to assemble, some choice as to location of the ships is possible. If we accept as the primary criterion the necessity for defending against attacks from the nose, level and high areas, some choices are clearly indicated. Of the formations shown in Inclosure 28 the formation of each size which is strongest against these attacks is:

4-Plane 1B (or 4-Plane 1C High)
5-Plane 1B 1D
6-Plane C High (or 6-Plane B)
7-Plane C High 1B
8-Plane C High 1B 1D (or 8-Plane B 2D)
9-Plane B D
10-Plane 1C High B D
11-Plane C High B 2D
12-Plane C High B D

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VI. IMPROVEMENT OF DEFENSE BY GUNNERY TECHNIQUES

A. The Need for Improving the Quality of Supporting Gunfire.

(1) The discussion thus far has related to the problems of formation defense without reference to the quality of the gunnery. It cannot be overemphasized that the strongest defense of unescorted B-29 formations is good gunnery. Any substantial improvement in the performance of the four men whose primary function is to defend the bomber, together with the bombardier for whom it must be a secondary duty, would undoubtedly do more to counter the enemy than any number of geometrical schemes to rebrief or restack the formation. To this end, there are included below a few suggestions for improving gunnery which, it is believed, merit consideration both in the field and in the training commands.

(2) The primary defensive reason for flying bombers in formations is to attain mutual fire support. This implies that gunners should fire not only at enemy fighters which are attacking their own plane, but also at all fighters within range which are menacing the formation. Most gunnery training and techniques place so much emphasis on firing only at fighters with guns bearing that they are unsuited to the development of effective support fire.

B. Improving the Technique of Ranging.

(1) Nowhere is this more clear than in the technique by which most gunners frame their targets to introduce the range factor in their firing. At present the gunner is trained to frame his target in such a way that the fighter's largest dimension equals the diameter of the circle of his reticle. When the fighter's guns are bearing on the gunner's own plane, this largest dimension is the wing span, and the correct range will be fed to the computer. In support fire, when the fighter is attacking another bomber, or on breakaways, the aspect of the fighter viewed by the gunner is such that the largest dimension is always less than the full wing span. Consequently the gunner will consistently underframe and over-range his target when his target dimension dial is set at wing span. If support fire is to be effective, the



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framing technique must introduce more nearly correct ranges.

(2) This can be accomplished by training the gunners in the following rule of thumb:

RANGING RULES FOR SUPPORT FIRE

Whether the fighter is attacking you, attacking another bomber, preparing to attack, or breaking away after an attack, --

I. Always place the pipper on the middle of the fuselage at the leading edge of the wing (roughly at the pilot's seat) of your target.

II. Frame your target so that the circle of your reticle just touches the part of the fighter which is furthest from the pipper.

(3) Inclosure 30 shows for different aspects of a Zero how this should be done. For the use of Gunnery Officers it also shows the difference in the placing of the pipper and the framing of the target which results from the method as compared with the technique now in use. In consideration of this technique, the following facts should be borne in mind.

a. This involves no change in the framing of a fighter with guns bearing on the gunner's own ship, but eliminates the consistent over ranging on support fire.

b. Tests with gunners show that it is impossible for a man to focus his eyes on both wing tips at once, so in reality, a gunner is framing a fighter with guns bearing by placing his pipper on the cockpit and using the distance to the wing tip as a radius to determine the outside limits of his reticle circle. Thus radius framing on support fire should offer no new problems to the gunner once he understands the purpose involved. In fact, his task is simplified in the sense that he always is centering his aim on the same part of the target.

c. Measurements of the dimensions of Japanese fighters show that from any aspect other than head on, the largest dimension visible, when measured from the cockpit, closely approximates one-half of the wing span.

C. Improving the Technique of Search.

(1) It is likely that the technique of search can be more closely related to the probable direction of attacks than is now the case. With the exception of the small number of Japanese attacks which originate as a tail





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chase, in which event there is generally ample time to pick up the target, all other attacks on a formation show that the relative motion of the fighter is from the nose of the bomber toward the tail. (See Inclosure 31 for a graphic illustration of the relative paths flown in representative fighter attacks.) This implies that the best preparation against an attack would be to:

RULES FOR EFFECTIVE SEARCHING

I. Carry the guns in each turret pointed as close to 12 o'clock as the area of search and fire is briefed to cover.

They would then be in a position to pick up the fighter in the direction from which he will first appear, and track him in the direction in which he will move.

II. Concentrate the search primarily in the area from which the fighters must first appear.

This means that a gunner searching the area 10-2 should spend more time searching 12 than 11 and 1, or 1 and 2; a gunner searching 2-6 should spend more time searching 2 than 3, 4, 5, or 6; and a gunner searching 5-7 should spend more time searching 5 and 7 than 6. This should not be interpreted to suggest that search of the less likely areas should be neglected, but rather that search should be focussed more frequently on the most likely areas.

III. Maintain the present technique of scanning, systematically searching various sectors of the sky. Stop at each sector long enough to permit the eyes to focus.

In this connection, it is appropriate to mention that no gunner should be expected to search effectively in a sector covering more than 180° in azimuth, and that his effectiveness should increase markedly as his sector is reduced to 120° or less.



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chase, in which event there is generally ample time to pick up the target, all other attacks on a formation show that the relative motion of the fighter is from the nose of the bomber toward the tail. (See Inclosure 31 for a graphic illustration of the relative paths flown in representative fighter attacks.) This implies that the best preparation against an attack would be to:

RULES FOR EFFECTIVE SEARCHING

I. Carry the guns in each turret pointed as close to 12 o'clock as the area of search and fire is briefed to cover.

They would then be in a position to pick up the fighter in the direction from which he will first appear, and track him in the direction in which he will move.

II. Concentrate the search primarily in the area from which the fighters must first appear.

This means that a gunner searching the area 10-2 should spend more time searching 12 than 11 and 1, or 1 and 2; a gunner searching 2-6 should spend more time searching 2 than 3, 4, 5, or 6; and a gunner searching 5-7 should spend more time searching 5 and 7 than 6. This should not be interpreted to suggest that search of the less likely areas should be neglected, but rather that search should be focussed more frequently on the most likely areas.

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D. Firing on Breakaways through the Tail Cone.

(1) Observation of fighter attacks on B-29's as made by a number of different type fighters, including jet-propelled P-80's, substantiated by extensive calculations of pursuit courses and strafing attacks made at different bomber and fighter speeds and with different "Gee" loadings restricting the fighter's rate of turn, indicate a striking fact:

IT IS VIRTUALLY IMPOSSIBLE FOR ANY FIGHTER ATTACKING A B-29, REGARDLESS OF THE DIRECTION AND ELEVATION FROM WHICH HE STARTS HIS ATTACK, TO AVOID PASSING THROUGH THE TAIL CONE OF FIRE FROM THE B-29 BEING ATTACKED. Almost invariably he will pass through a sphere about 100 yards in radius centered at a point about 300 yards behind the bomber being attacked, and he will be in this sphere approximately 3 seconds after the instant when his guns were bearing at 600 yards range on the way in. (See Inclosure 31.) In many passes the motion of the fighter results in a no-deflection shot for the tail gunner, either in the ship under attack or in other ships in the formation.

(2) This fact presents some intriguing possibilities which we should hasten to exploit. Long range projects might involve the development of special weapons, but this is not the purpose of the present report. As an immediate program in the field, in order to take advantage of the opportunity of firing at breakaways as they pass through the tail cone, it is recommended that:

a. The copilot should report on interphone all forward hemisphere attacks. Such reports should include the conventional procedure of calling each attack by clock position and high, level or low, including the repetition of the word "ATTACK" at the instant when the fighter is committed to attack.

b. The tail gunner should be ready with sight pointed in the direction from which the target is expected to appear. At 4-5 seconds after the word "ATTACK" is first called he should be able to get in a short burst at a range of about 3-500 yards. Since the most effective of these shots will be the occasional ones for which the deflection if small, the reticle should be kept at minimum range setting (maximum size of reticle circle) to reduce errors from slewing and from the high initial tracking rate.

(3) With a little practice the gunners firing these breakaway



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shots will learn in what part of their cone of fire to have their guns pointed in order to be aiming toward the fighter when he appears. They should also be able to develop such a sense of timing that they can commence firing at the right instant. Success of this technique will depend upon the ability of all gunners to act as a team, timing their calls accurately and adding whatever information may prove necessary in regard to the fighter's choice of breakaway.

(4) It cannot be expected that a very large proportion of hits will result since the period of engagement will be short and little tracking will be possible. But every hit scored here may eliminate one experienced attacker of succeeding formations or on successive days. Moreover, except during the infrequent tail attacks, the tail guns are otherwise unable to use their ammunition to help protect the formation.

E. Teaching Gunners When and Where and How to Fire.

(1) It would probably lead to somewhat more effective use of our defensive gunnery if, without disturbing morale by overemphasizing the imperfections of the CFC system, gunners could be taught enough about the angles-off and maximum leads to have a clear appreciation of the areas within the sectors they are defending where their fire is most, and least accurate. Also of the directions from which fighter fire is most and least accurate. Inclosure 32 is designed as a suggestion of a poster for gunners, which might emphasize the proper points without introducing technicalities or raising serious doubts about the equipment they are using.

(2) Although it is probably difficult to persuade gunners of the advisability of withholding fire, and it is unreasonable to expect that they are capable of estimating range with much precision, the effect of range on bullet dispersion and accuracy, and the effect of overheating guns on accuracy should be fully understood by combat gunners. Extensive tests show:

a. The extreme improbability of hitting a target when its future range is in excess of 600 yards.

b. Long bursts overheat guns so that bullets keyhole. If gunners open fire on an attacking fighter too soon, they will first be inaccurate because of excessive range, then as the fighter comes closer, where they should be able to hit him, they will be inaccurate because their guns are overheated.



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(3) Therefore, more effective defense would be achieved if gunners opened fire at approximately 1000 yards at fighters attacking from the nose, and 600 yards on attacks from the beam or tail. Within these ranges long bursts should be used. If firing is opened at greater ranges, it is exceedingly important to fire in short bursts.

F. Improving the Accuracy of Fire against Nose Attacks.

(1) It is well known that the effectiveness of our fire against nose attacks is far from adequate. Given the high closing speed between bomber and fighter it is apparent that the present computer cannot be driven fast enough to provide the correct solution for firing. The Conference considered various alternative makeshift remedies to this situation: using the computer, spinning the range wheel from long to short range in the attempt to offset the computer lag, point blank fire with the computer off, and the use of emergency position firing rules with the computer placed on standby. The consensus of opinion was that insufficient evidence existed to justify a clear preference for any of these alternatives. However, two other methods, one involving a simple field modification at the computer, the other involving a modified zone system of firing, are now being investigated. If either method proves effective, reports to that effect will be prepared and distributed.

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VII. RECOMMENDATIONS PERTAINING TO TRAINING.

Although the primary purpose of the Conference was to devote its attention to problems of fundamental interest to overseas Commanders, and to seek quick solutions which could be of immediate benefit to men in combat, it is impossible to overlook the training aspects of the subjects which have been considered. Each conclusion and each recommendation coming from the Conference has implications for training. Those which are accepted by the Twentieth Air Force and its Constituent Bomber Commands should be immediately introduced into the training program.

A. Preliminary Training in Gunnery Techniques as They Relate to Formation Flying.

(1) No procedures for turret allocation and briefing of areas of search and fire will work unless the combat crews are trained in them. There are now accepted standard names for the principal variations of turret allocation, and with each such allocation is associated a rather definite set of limits of sectors of search and fire. In addition, a standard target reporting procedure is specified in XX Bomber Command Tactical Doctrine. Although the Second Air Force has made a significant start preparing a S.O.P. Manual for Crew Coordination, many parts of which are already incorporated in XX Bomber Command Tactical Doctrine, the Conference is informed that little crew coordination training is actually in effect. The Conference believes that in their second six weeks of training gunners should be taught these things until they become second nature.

(2) Accordingly, it is recommended that during this training period gunners should learn and practice:

a. The terminology of different turret allocations within the airplane as now specified in XX Bomber Command Tactical Doctrine (Inclosure 13).

b. Rules for turret allocation corresponding to the position of the airplane in the element and of the element in the formation (see recommendations in III C of this report).

c. Rules and reasons for briefing areas of search and fire (see recommendations in III D of this report).

d. Intercom procedure of target reporting as now specified in XX Bomber Command Tactical Doctrine (Inclosure 13).



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(3) If own formation damage is to be held to a minimum the gunners must have an appreciation of the deflection between the line of the sight and axis of bore of the guns. The lead and parallax corrections introduced by the computer should be understood if they are to be taken into account in determining safe areas for search and fire. The gunner should also understand the effects of rapid slewing, not only to avoid hitting friendly planes, but to enable him to come onto a target with as little disturbance to the computer as possible.

(4) Since the accuracy of fire varies greatly with range and also with the angle-off, it is important for the gunner to fire when these factors are most favorable and to avoid wasting ammunition when they are not. This may be accomplished by a few simple rules, but it is believed that to apply such rules effectively the gunner should have a general acquaintance with the dependence of lead upon relative motion and with the way bullet density changes with range. The gunner will be more willing to forego firing at large angles-off, where the danger of own formation damage is greatest, if he understands the difficulties encountered by the fighter in attacks from the beam.

(5) The technique of ranging for formation defense must give accurate results for support fire as well as for fire from the ship under attack. For this purpose a simple radius framing method of ranging has been suggested in Section VI of this report. It is recommended that this system be incorporated into the training program.

(6) The technique of searching for targets has received little attention in the past. Suggestions are made in Section VI of this report regarding the proper distribution of attention over the area of search for which each gunner is responsible, and the technique of focussing the eyes in each region before going on to the next. These and similar questions should be studied further and the results included in gunnery training.

B. Flight Training in Formation Gunnery.

(1) Flight Training in the last six weeks Operational Phase Training has much to accomplish if effective formation defense is to be achieved.



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The Conference recommends that:

a. Formation flying should be practiced with close formations of at least 9 aircraft.

b. The formations should be attacked by experienced fighters using coordinated attacks.

c. If possible, within the limits of safety, such attacks should include nose passes. Pilots are available at the 200th Base Unit, Alamogordo, New Mexico who are fully experienced in doing this, and until a bomber crew member has seen a nose attack on a B-29 he has no notion of the speed of these engagements and of the gunnery problem involved.

(2) During this simulated combat, the training should include practice in intercom procedure and target reporting, with close adherence to the procedure prescribed in the Tactical Doctrine. Practice in coordination for tail breakaway shots might also be tried. While actually flying in formation the crew should practice the other procedures of crew coordination, including the technique of turret exchange in response to a central command giving the allocation. Even though turret exchanges may be infrequent in combat, the times when they will be needed can tolerate no confusion or delay.

a. For example, if the command HI GAN RIGHT comes over the interphone, the gunnery team must be able to respond correctly at once without confusion. Then if GANG LOW LEFT is next heard, they must be able to switch turrets to correspond to the new allocation.

b. For each allocation the gunners should select appropriate areas of search and fire, depending upon the actual position of other planes in the formation. The rules and reasons for these areas should be emphasized while in flight.

(3) The gun camera work on formation flying missions should stress own formation damage fully as much as accuracy of tracking and framing.

a. In this connection it might be a good idea to show the film in which one B-29 is "shot" by another to both the crew of the "shot up" plane and the offending plane simultaneously. This would have a more powerful psychological effect than merely having an instructor point out the error.

b. The new radius phasing technique to improve ranging on support fire should also be emphasized during gun camera film assessment.





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c. During simulated combat the attacking fighters should shoot film which can be assessed to improve fighter gunnery and should also be shown to bomber crews. The object of the fighter is to bring down the bomber without being shot down himself. Not only can his film show his own score, but also will generally indicate whether the bombers' guns were on him or not.

C. Implementing the Training Program.

(1) It must be recognized that to make recommendations, or even to issue authoritative directives calling for the effectuation of such a training program will, in itself, have little practical effect. At present there are no instructors or Gunnery Officers acquainted with this program as outlined. Moreover there are no appropriate lesson plans nor training manuals on formation defense except the partially obsolete 2nd Air Force Manual 50-64 which relates to an 11-plane formation.

(2) To implement this program, it is recommended that:

a. A training manual and lesson plans be prepared, incorporating the relevant parts of the Tactical Doctrine together with such sections of this Report as gain concurrence.

b. A travelling school be established as soon as these materials are ready, to go to Training Command advanced training bases and to Training Air Force operational training bases to institute a full-fledged program of training in crew coordination and formation defense.

c. This school should be conducted for instructors and gunnery officers to teach them what to teach. Experience has demonstrated that they will not find out by reading directives and training manuals. The whole gun camera program hinged on following a printed gun camera manual and proved to be unsuccessful because no one taught the instructors how to use the manual.

d. The officers who prepare the lesson plans and training manual should be the instructors in this travelling school since they will be most familiar with the program.

(3) It will be noted that under date of 5 March 1945 the Second Air Force has requested Training Command to establish a school of one week's duration to qualify instructors on B-29 gunnery.

D. Presentation of Formation Gunnery to Gunners and Training Personnel.

(1) THE FIRST AND BASIC REQUISITE FOR FORMATION GUNNERY IS SUPPORT FIRE. Without support fire there is little defensive reason for flying



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bombers in formations rather than singly. With it the defense of each ship is augmented by the fire power of others.

(2) In the early development of gunnery training, there emerged an idea which almost completely nullifies the principle of mutual fire support. This idea is the old position firing doctrine "Don't shoot at him unless he is shooting at you". This doctrine was an unfortunate necessity when position firing had to be used because the leads were correct only when the fighter was flying a gun bearing course. With a computing sight, and proper tracking and framing, a fighter can be hit regardless of whom he is attacking, or when he is not attacking at all.

(3) The Conference is given to understand that the position firing doctrine persists in the training of B-29 gunners destined for combat.

(4) Accordingly it is recommended that an energetic campaign to root out the position firing doctrine be conducted among enlisted instructors and gunnery officers. The potentialities of the computing sight, and the basic necessity for support fire for formation defense should be carefully explained, and all references to the position firing dogma should be deleted from all training materials.

(5) Failure to do this will cancel almost all the defensive advantages of formation flying.

a. Consider, for example, what will happen on a nose pass on another bomber in your element, or on a bomber in the next element if your gunners take literally the self-defense doctrine. At very long range the fighter might appear to be attacking your ship and your gunner might fire a few shots of too long range to be effective. Then at just the time the fighter came well in range where the gunner could provide some really effective support fire, he would see by the fighter's aspect that it was not attacking your ship. In fact its aspect to you would make it look as if the fighter were making a breakaway. In this case your gunner would obediently let up on his triggers and allow your neighboring ship to defend himself with two guns against the fighter's six or eight. Even the wording of the XX Bomber Command Tactical Doctrine needs some clarification on this subject, but the principal point at which this sort of error must be eradicated is at the level of training.

B. Additional Aids to Effective Formation Gunnery.

(1) The staff at Mount Wilson Observatory has experimented with



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still and motion pictures of models of B-29's. Prints are available showing what can be done:

a. To simulate fighter attacks on the formation from all angles and show what formation gunfire is available to defend against each attack at each point on the way in. These movies also serve to show gunners what the fighter attack will look like in relative motion, and at what points of his attack course he can fire.

b. To simulate a fighter circling the formation and indicate the number of bomber guns bearing at each clock angle, low, level, and high.

All who have seen these pictures are enthusiastic about their possibilities for use both as training aids and as means of assessing proposed changes in tactical doctrine. The Committee recommends that steps be taken to obtain the present prints for use at Training Command and Training Air Force levels, and that the possibility be explored of extending the use of photography for this purpose.

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VIII. ACKNOWLEDGMENTS.

1. The members of the Conference wish to express their appreciation to Dr. Walter S. Adams, Director, and to the entire staff of Mount Wilson Observatory for the voluntary donation of their expert services and for the cordiality with which the facilities of the Observatory have been placed at the disposal of the Conference.

2. Acknowledgments for source material are due to the NDRC Project AC-92, both the Mount Wilson Observatory Project and the University of New Mexico Project, to the Research Division, Central School for Flexible Gunnery, Laredo Army Air Field, to Operations and Training and Operations Analysis Section, Second Air Force, to 206th and 231st Base Units at Army Air Field, Alamogordo, New Mexico, to Hq. and Operations Analysis Section XX Bomber Command, to Hq. and A-2 XXI Bomber Command and to Hq. and Operations Analysis Division, Twentieth Air Force.

Pasadena, California
8 March 1945

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Inclosure 1.

HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D. C.

6 February 1945

MEMORANDUM TO CONFERENCE ON FORMATION DEFENSE,
Pasadena, California

Subject: Formation Defense

1. The Twentieth Air Force is now bombing Japan from formations of twelve B-29's employing interplane spacings, turret controls and restrictions as to areas of search and fire as prescribed in XX Bomber Command Tactical Doctrine. It is the desire of the Twentieth Air Force that this doctrine be carefully evaluated so that, as Japanese air opposition grows, every feasible step will be taken to insure the maximum defense of our formations.

2. Accordingly, it is requested that the Committee now meeting in Pasadena study the currently used formation, and submit to the Twentieth Air Force its recommendations as to means of improving B-29 formation defense. It is hoped that this study will combine the firepower measurement techniques developed at the Mount Wilson Observatory with current knowledge of CFC system accuracy, practical experience regarding formation flying and combat gunnery, and intelligence concerning enemy performance, tactics, and capabilities in such a way that sound answers can be given to the following questions:

a. Taking the 12 plane formation as presently prescribed, what is the relative firepower it can deliver to various parts of the sphere surrounding the formation? Against what directions of attack is it particularly strong or weak?

b. Based on fighter capabilities, enemy tactics, and CFC accuracy, against what directions of attack is it most important to concentrate our defensive firepower? What zones require less protection?

c. What changes in the presently briefed areas of search and fire would afford greater protection against attacks on the formation's most vulnerable areas? How should turret exchanges be used to mass defenses against various types of attacks?

d. What changes in the presently prescribed interplane spacings would afford greater protection against attacks on the formation's most vulnerable areas? What sacrifice of protection is incurred when the formation is flown less tightly than prescribed, say, when its breadth and length is doubled?

e. If operational difficulties prevent the assembly of balanced 12 plane formations, what doctrines should govern the spacing, turret assignments, and briefed areas of search and fire for smaller formations?

f. What other recommendations can be made to improve the defense of B-29 formations?

3. Colonel William P. Fisher, Deputy Chief of Staff, and Dr. Richard G. Gettell, Operations Analyst, are designated as the representatives of the Twentieth Air Force at this Conference. Colonel Fisher will convene the Conference, explain the purpose thereof, and thereafter Dr. Gettell will act as Chairman and Coordinator.

/s/ Lauris Norstad
LAURIS NORSTAD
Brigadier General, U.S. Army
Chief of Staff.

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MEMBERS OF THE PASADENA CONFERENCE

ON

DEFENSE OF B-29 FORMATIONS

Twentieth Air Force

| | |
|---|---|
| Col. William P. Fisher | Deputy Chief of Staff |
| Dr. Richard G. Gettell | Deputy Chief, Operations Analysis Division |

Second Air Force

| | |
|---|---|
| Col. William J. Bohnaker | Director, Very Heavy Training |
| Lt. Col. William S. Evans | Director, Flying Training |
| Maj. William O. Keys | Gunnery Officer |
| Maj. William H. Gauss | Gunnery and Armament Officer, 206th B.U. |
| Maj. Don Blondis | Gunnery Officer, 16th Wing |
| Maj. Robert W. Isaacson | Gunnery Liaison Officer |
| 2nd Lt. John E. Newman | Gunnery Liaison Officer |
| Dr. William L. Duren, Jr. | Operations Analyst |

Army Air Forces Board

| | |
|---|---|
| Lt. Col. John H. Diehl, Jr. | Head, Gunnery and Special Weapons Branch, Tactics Division |

Training Command

| | |
|---|---|
| Capt. Warren S. Rowe | Supervisor of Flight Training, Combat Gunnery Officers' School, Laredo, Texas |

NDRC Project AC-92, Mount Wilson Observatory

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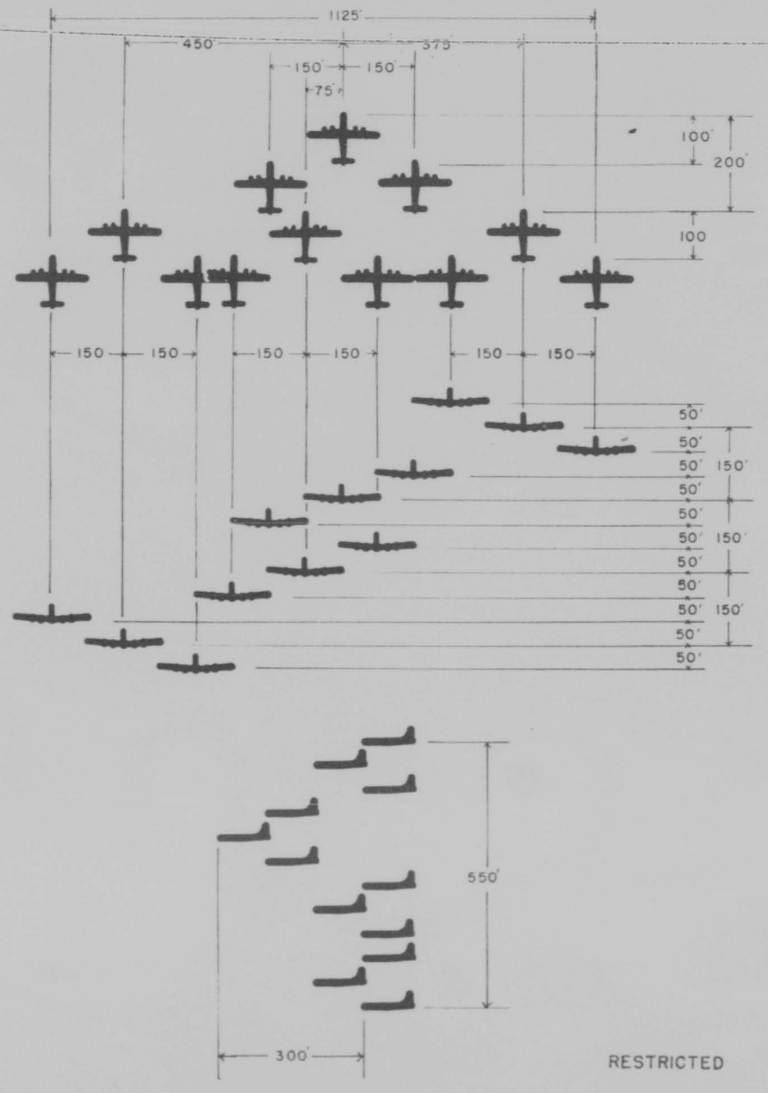
STANDARD 12-PLANE B-29 FORMATION

Inclosure 3

XX Bomber Command Tactical Doctrine

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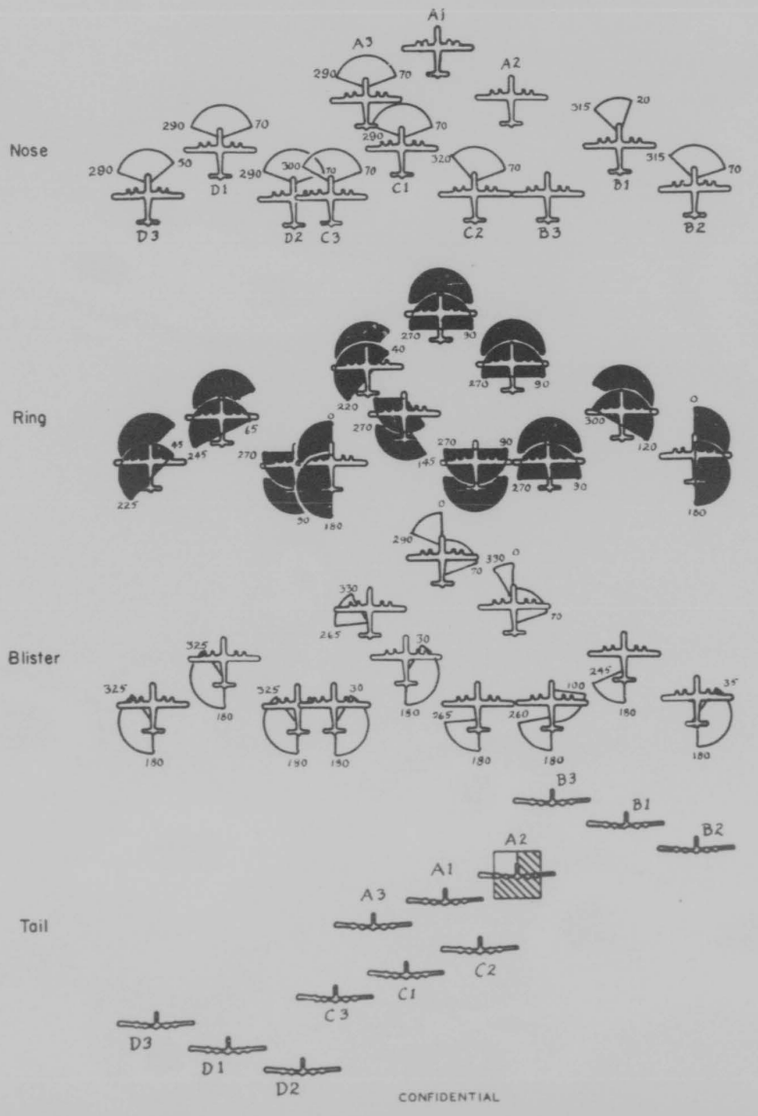
Inclosure 4

TURRET ASSIGNMENTS, BRIEFED AREAS OF SEARCH AND FIRE

Standard 12-Plane B-29 Formation

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TURRET ASSIGNMENTS

12-PLANE FORMATION AS PRESENTLY BRIEFED

Extracted from XX Bomber Command Memorandum 373E, dated 1 November, 1944

(The table of fire control procedures is given for Low Element Left only, the case of Low Element Right being omitted. Notes have been added to this table to indicate various special conditions referred to in the present report.)

SUBJECT: Operating Procedures, Control of Turrets, Areas of Search and Fire.

1. In order to insure maximum efficiency of turret control, search and fire for formation defense by aircraft of the Command, the following procedureswill be established:

a. Twelve aircraft:

| Airplane No. | | Gunner | Notes | LOW ELEMENT LEFT Area Search | Initial Control |
|---|---|---|---|---|---|
| 1 | A-1 | TOP | | 270-90-High | UF-UA |
| | | NOSE | | None | None |
| | | RIGHT | | 0-70-Low | LA |
| | | LEFT | | 290-360-Low | LF |
| | | TAIL | (1) | 150-210 | Tail |
| 2 | A-2 | TOP | | 270-90-High | UF-UA |
| | | NOSE | | None | None |
| | | RIGHT | | 0-70-Low | LA |
| | | LEFT | | 330-360-Low | LF |
| | | TAIL | (5) | 180-210-High | Tail |
| 3 | A-3 | TOP | (1) | 220-40-High | UF-UA |
| | | NOSE | | 290-70-Low | LF |
| | | RIGHT | | 35-125-Low | None |
| | | LEFT | (2) | 265-330-Low | LA |
| | | TAIL | (5) | 150-210 | Tail |
| 4 | B-1 | TOP | | 300-120-High | UF-UA |
| | | NOSE | (3) | 315-20-Low | LF |
| | | RIGHT | | 30-110-Low | None |
| | | LEFT | | 180-245-Low | LA |
| | | TAIL | | 150-210 | Tail |
| 5 | B-2 | TOP | | 0-180-High | UF-UA |
| | | NOSE | | 315-70-Low | LF |
| | | RIGHT | | 35-180-Low | LA |
| | | LEFT | | 180-260-Low | None |
| | | TAIL | | 150-210 | Tail |
| 6 | B-3 | TOP | | 270-90-High | UF-UA |
| | | NOSE | | 0-40-Low | None |
| | | RIGHT | | 100-180-Low | LF |
| | | LEFT | | 180-260-Low | LA |
| | | TAIL | | 150-210 | Tail |



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| Airplane No. | | Gunner | Notes | LOW ELEMENT LEFT Area Search | Initial Control |
|---|---|---|---|---|---|
| 7 | C-1 | TOP | (1) | 145-270-High | UF-UA |
| | | NOSE | | 290-70-Low | LF |
| | | RIGHT | | 30-180-Low | LA |
| | | LEFT | | 270-325-Low | None |
| | | TAIL | | 150-210 | Tail |
| 8 | C-2 | TOP | (1) | 90-270-High | UF-UA |
| | | NOSE | | 320-70-Low | LF |
| | | RIGHT | | 30-180-Low | None |
| | | LEFT | | 180-265-Low | LA |
| | | TAIL | | 150-210 | Tail |
| 9 | C-3 | TOP | | 180-0-High | UF-UA |
| | | NOSE | (2) | 300-70-Low | LF |
| | | RIGHT | | 30-180-Low | LA |
| | | LEFT | | 180-245-Low | None |
| | | TAIL | | 150-210 | Tail |
| 10 | D-1 | TOP | (1) | 245-65-High | UF-UA |
| | | NOSE | | 290-70-Low | LF |
| | | RIGHT | | 30-105-Low | None |
| | | LEFT | | 180-325-Low | LA |
| | | TAIL | | 150-210 | Tail |
| 11 | D-2 | TOP | (1) | 90-270-High | UF-UA |
| | | NOSE | | 290-70-Low | LF |
| | | RIGHT | | 30-180-Low | None |
| | | LEFT | (4) | 180-375-Low | LA |
| | | TAIL | | 150-210 | Tail |
| 12 | D-3 | TOP | | 225-45-High | UF-UA |
| | | NOSE | (1) | 290-50-Low | LF |
| | | RIGHT | | 100-180-Low | None |
| | | LEFT | | 180-325-Low | LA |
| | | TAIL | | 150-210 | Tail |

Notes, added to table:

(1) Area of search and fire includes friendly ship.

(2) Probability of damage to friendly ship due to insufficient allowance for deflection.

(3) Probably intended to read "315-70-Low".

(4) Probably intended to read "180-325-Low".

(5) If Ship 2 needs restriction, Ship 3 probably does also.

The preceding fire control plan is based on 12 airplanes flown in prescribed formation. If the prescribed formation is not flown the following principles will govern the gunners control, search and fire:

INITIAL CONTROL OF TURRETS

1. All top gunners will have initial control of UF-UA Turrets.
2. In all planes except those of the leader and deputy leader the bombardier will have control of LF turret.
3. In all planes on the Left of the lead plane, the left gunner will have initial control of the LA Turret.



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4. In all planes on the right of the lead plane the right gunner will have initial control of the LA Turret.
5. Tail gunner will have initial control of the Tail Turret.

AREAS OF SEARCH AND FIRE

1. All top gunners of planes on the leading edge of the formation will cover the forward section from 270° - 90°. All top gunners in planes on the inside of the formation will cover the rear section 90° - 270°.

2. In all planes except those of the leader and deputy leader the bombardier will cover the lower forward area.

3. All left gunners will cover the lower hemisphere from 180° - 300°.

4. All right gunners will cover the lower hemisphere from 60° - 180°.

5. All tail gunners will cover upper and lower hemisphere within the limitations of their sights.

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NUMBER OF B-29 GUNS BEARING
AT INFINITE DISTANCE
12-PLANE FORMATION AS PRESENTLY PRESCRIBED

| Clock Angle | High | Level | Low |
|---|---|---|---|
| 10 | 30 | 26 | 21 |
| 11 | 32 | 17 | 25 |
| 12 | 24 | 17 | 22 |
| 1 | 32 | 16 | 23 |
| 2 | 22 | 23 | 24 |
| 3 | 18 | 12 | 6 |
| 4 | 10 | 6 | 8 |
| 5 | 30 | 28 | 24 |
| 6 | 50 | 39 | 43 |
| 7 | 34 | 31 | 28 |
| 8 | 20 | 12 | 11 |
| 9 | 28 | 18 | 8 |

(Each value in this table represents an average over the section of sky indicated by the level and clock angle.)





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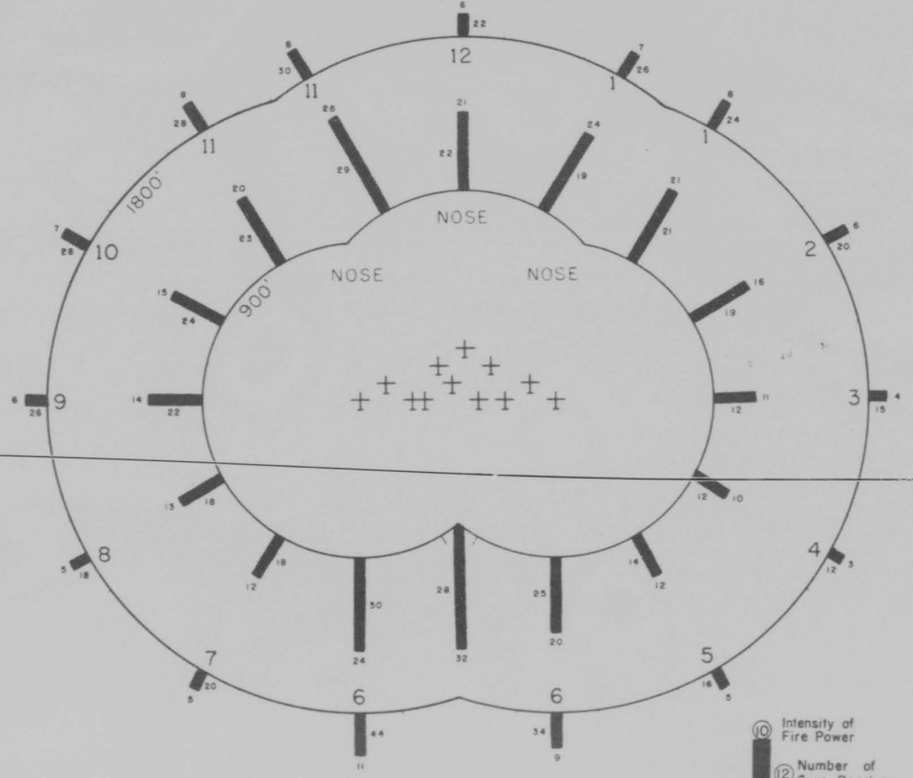
Inclosure 6
Page 1

# INTENSITY OF FIRE POWER WHICH CAN BE DIRECTED TO VARIOUS POINTS IN THE SKY

## Standard 12-Plane B-29 Formation




A. ELEVATION HIGH

The three sections of each curve are parts of circles surrounding the lead ship and the two wing ships. The range for the outer set of measurements is 600 yards, for the inner one 300 yards.

The figure at the top of each stack gives its height, which equals the relative firepower at that position, including the effect upon bullet density of the range from each plane in the formation.

The figure beside each stack gives the number of guns which can be brought to bear, neglecting the effect of range.

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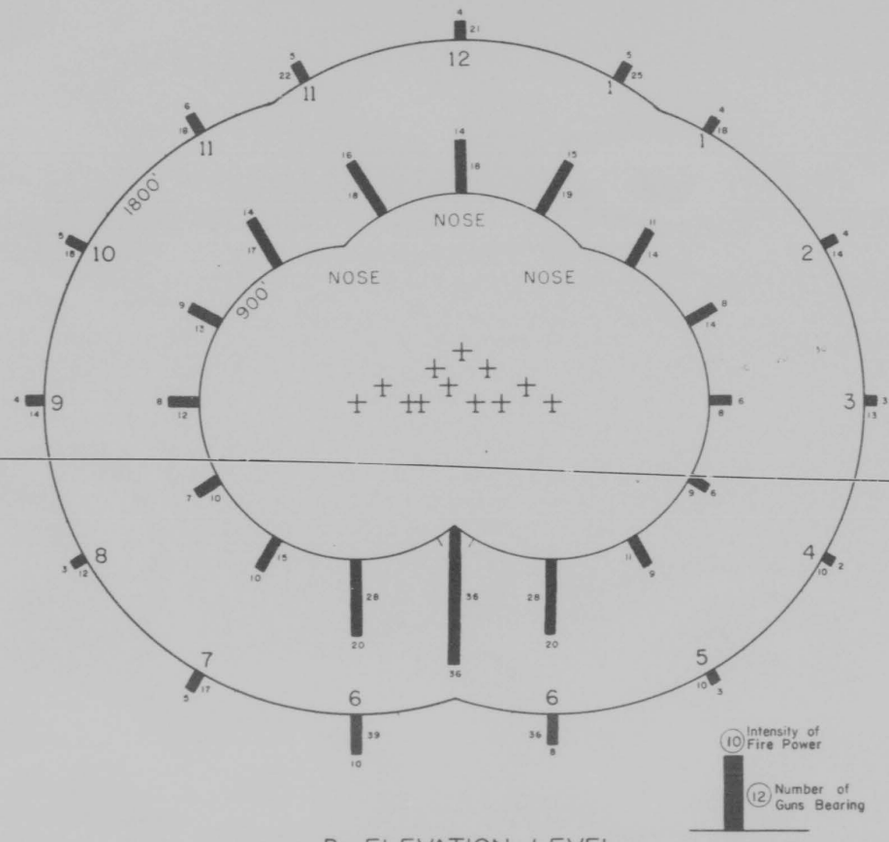
INTENSITY OF FIRE POWER WHICH CAN BE DIRECTED TO VARIOUS POINTS IN THE SKY

Standard 12-Plane B-29 Formation




B. ELEVATION LEVEL



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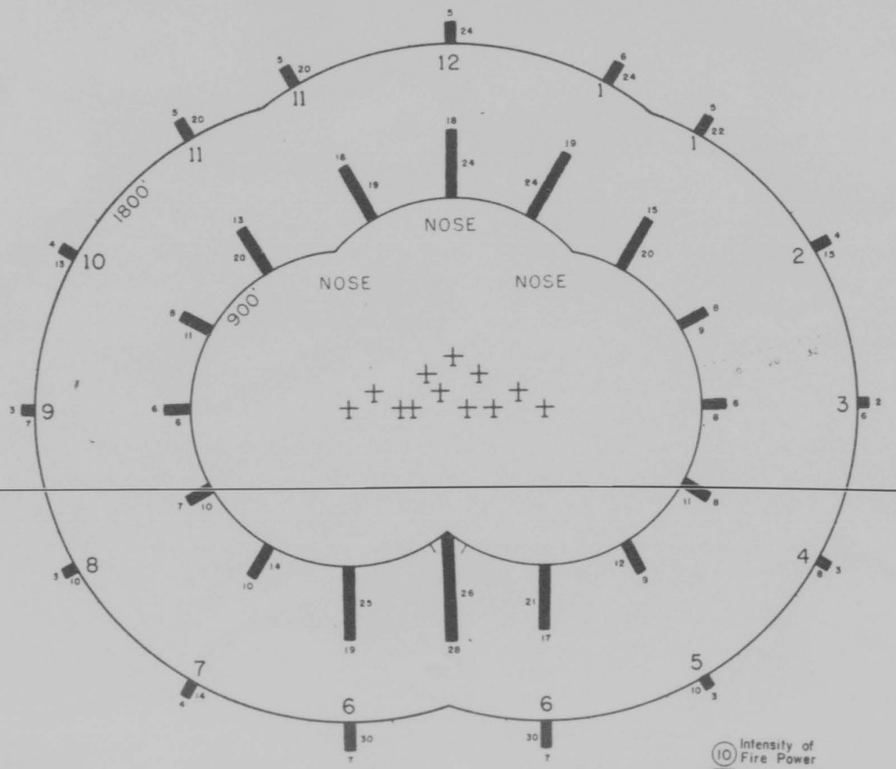
INTENSITY OF FIRE POWER WHICH CAN BE DIRECTED
TO VARIOUS POINTS IN THE SKY

Standard 12-Plane B-29 Formation




C. ELEVATION LOW

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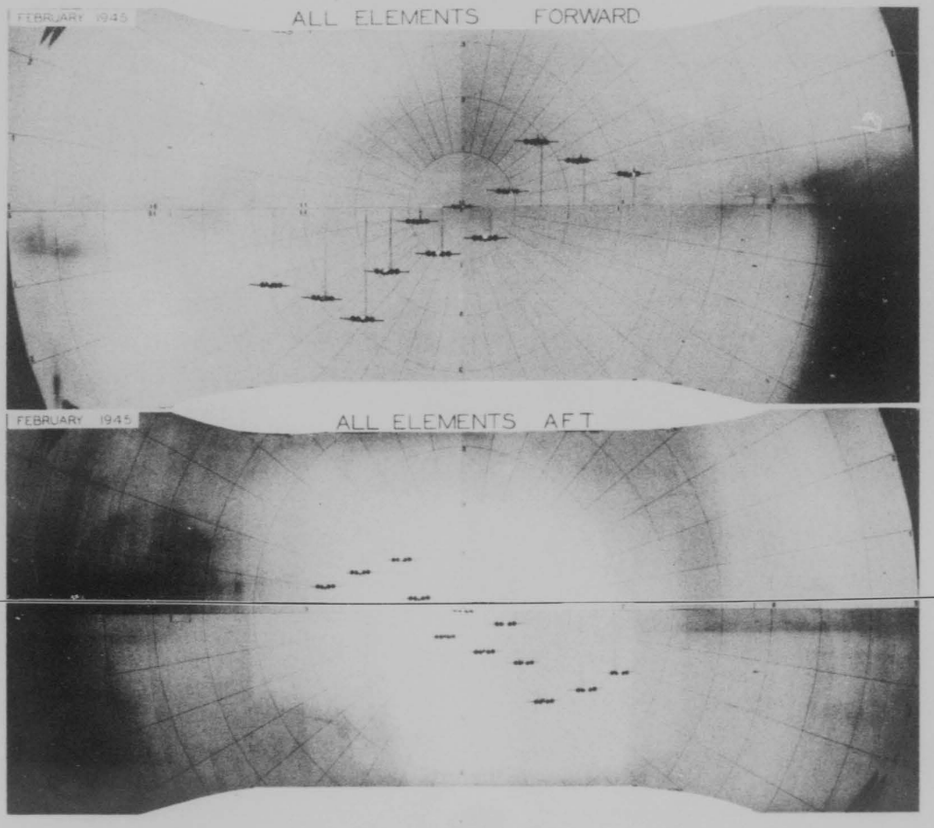
PHOTOGRAPHIC ANALYSIS OF DEFENSIVE FIRE POWER
Standard 12-Plane Formation of B-29's
ORIGINAL BRIEFING




Light areas indicate directions in which firepower is more intense, dark areas less intense. Shadows of B-29's show possibilities of damage from friendly fire. Shadow surface is a spherical screen at range 600 yards from the lead ship.

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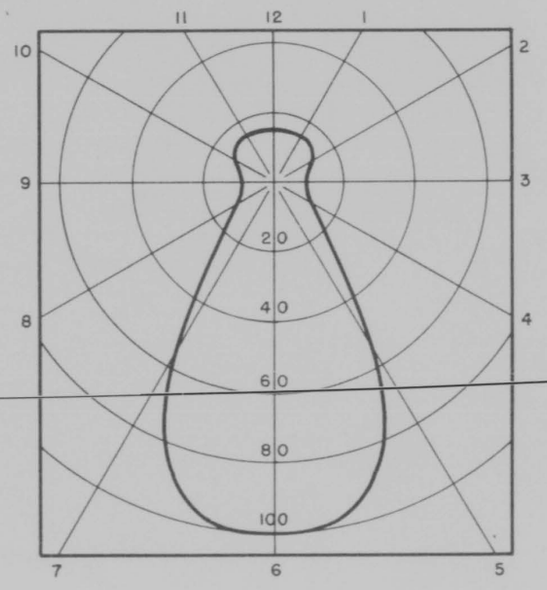
INDEX OF FIGHTER HITS PER PASS ON A B-29

100 = Number of hits scored during a pass from directly astern (6 o'clock).

The angle of the pass is taken as the angle at the midpoint of the fighter's burst.




(Data are for simulated attacks by P-47's against B-29's, and are taken from Fig. I-2, University of New Mexico Report, NDRC Project AC-92, 15 November, 1944.)

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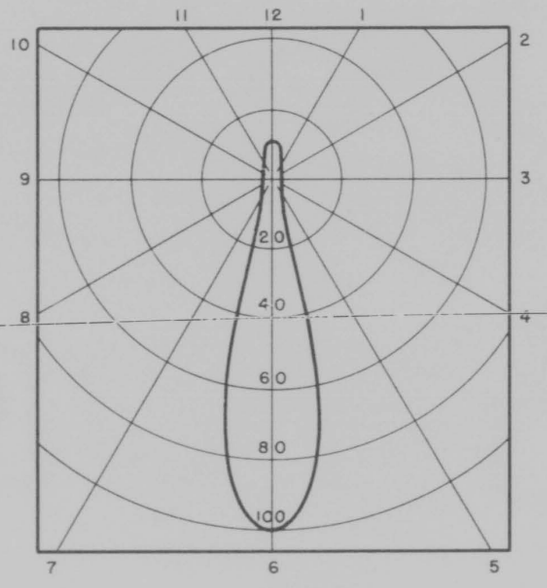
## INDEX OF B-29 HITS PER PASS ON A FIGHTER

100 = Number of hits scored against a pass from directly astern (6 o'clock)

The angle of the pass is taken as the angle at the time the bomber's guns are fired.




(Data are for simulated attacks by P-47's against B-29's, and are taken from Fig. II-8, University of New Mexico Report, NDRC Project AC-92, 15 November, 1944.)

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DIRECTION AND ELEVATION OF JAPANESE FIGHTER ATTACKS ON B-29's

| Clock Angle | Elevation | Number of Attacks | | | % of Total Attacks | | |
|---|---|---|---|---|---|---|---|
| | | XX BC Missions 18-27 | XXI BC Missions 7-14 | Total | Missions 18-27 | Missions 7-14 | Total |
| 10 | High | 75 | 31 | 106 | 8.4 | 1.8 | 4.1 |
| | Level | 15 | 62 | 77 | 1.7 | 3.6 | 2.9 |
| | Low | 7 | 63 | 70 | 0.8 | 3.7 | 2.7 |
| 11 | High | 88 | 112 | 200 | 9.8 | 6.5 | 7.7 |
| | Level | 14 | 58 | 72 | 1.6 | 3.4 | 2.8 |
| | Low | 15 | 63 | 78 | 1.7 | 3.7 | 3.0 |
| 12 | High | 67 | 99 | 166 | 7.5 | 5.8 | 6.3 |
| | Level | 18 | 78 | 96 | 2.0 | 4.5 | 3.7 |
| | Low | 19 | 99 | 118 | 2.1 | 5.7 | 4.5 |
| 1 | High | 70 | 113 | 183 | 7.8 | 6.6 | 7.0 |
| | Level | 33 | 73 | 106 | 3.7 | 4.2 | 4.1 |
| | Low | 23 | 101 | 124 | 2.6 | 5.9 | 4.7 |
| 2 | High | 82 | 58 | 140 | 9.1 | 3.4 | 5.4 |
| | Level | 10 | 34 | 44 | 1.1 | 2.0 | 1.7 |
| | Low | 21 | 55 | 76 | 2.4 | 3.2 | 2.9 |
| 3 | High | 43 | 31 | 74 | 4.8 | 1.8 | 2.8 |
| | Level | 20 | 54 | 74 | 2.2 | 3.1 | 2.8 |
| | Low | 55 | 30 | 85 | 6.1 | 1.7 | 3.3 |
| 4 | High | 12 | 5 | 17 | 1.3 | 0.3 | 0.6 |
| | Level | 4 | 23 | 27 | 0.5 | 1.3 | 1.0 |
| | Low | 21 | 12 | 33 | 2.3 | 0.7 | 1.3 |
| 5 | High | 12 | 29 | 41 | 1.3 | 1.7 | 1.6 |
| | Level | 11 | 12 | 23 | 1.2 | 0.7 | 0.9 |
| | Low | 22 | 28 | 50 | 2.5 | 1.6 | 1.9 |
| 6 | High | 9 | 31 | 40 | 1.0 | 1.8 | 1.5 |
| | Level | 8 | 39 | 47 | 0.9 | 2.3 | 1.8 |
| | Low | 18 | 42 | 60 | 2.0 | 2.4 | 2.3 |
| 7 | High | 9 | 26 | 35 | 1.0 | 1.5 | 1.3 |
| | Level | 2 | 34 | 36 | 0.2 | 2.0 | 1.4 |
| | Low | 21 | 25 | 46 | 2.3 | 1.5 | 1.8 |
| 8 | High | 5 | 11 | 16 | 0.6 | 0.6 | 0.6 |
| | Level | 0 | 19 | 19 | 0.0 | 1.1 | 0.7 |
| | Low | 15 | 20 | 35 | 1.7 | 1.2 | 1.3 |
| 9 | High | 26 | 51 | 77 | 2.9 | 3.0 | 2.9 |
| | Level | 15 | 52 | 67 | 1.7 | 3.1 | 2.6 |
| | Low | 11 | 44 | 55 | 1.2 | 2.6 | 2.1 |
| TOTAL | High | 498 | 597 | 1095 | 55.5 | 34.8 | 41.8 |
| | Level | 150 | 538 | 688 | 16.8 | 31.3 | 26.4 |
| | Low | 248 | 582 | 830 | 27.7 | 33.9 | 31.8 |
| TOTAL | | 896 | 1717 | 2613 | 100.0 | 100.0 | 100.0 |



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JAPANESE ATTACKS AND B-29 CLAIMS

According to Direction and Elevation

| DIRECTION OF ATTACK | | 12 | 11<br>1 | 10<br>2 | 9<br>3 | 8<br>4 | 7<br>5 | 6 |
|---|---|---|---|---|---|---|---|---|
| Number of Attacks Made | High | 166 | 383 | 246 | 151 | 33 | 76 | 40 |
| | Level | 96 | 178 | 121 | 141 | 46 | 59 | 47 |
| | Low | 118 | 202 | 146 | 140 | 68 | 96 | 60 |
| Total Claims: Destroyed, Probably Destroyed, or Damaged | High | 18 | 49 | 30 | 15 | 8 | 7 | 4 |
| | Level | 14 | 23 | 13 | 17 | 5 | 10 | 4 |
| | Low | 12 | 17 | 24 | 28 | 16 | 21 | 11 |
| % of Attacks on Which Claims Were Made | High | 11 | 13 | 12 | 10 | 24 | 9 | 10 |
| | Level | 15 | 13 | 11 | 12 | 11 | 17 | 9 |
| | Low | 10 | 8 | 16 | 20 | 24 | 22 | 18 |
| Number of Attacking E/A Which Escaped Damage | High | 148 | 334 | 216 | 136 | 25 | 69 | 36 |
| | Level | 82 | 155 | 108 | 124 | 41 | 49 | 43 |
| | Low | 106 | 185 | 122 | 112 | 52 | 75 | 49 |
| % of Total Undamaged E/A | High | 6.5 | 14.7 | 9.5 | 6.0 | 1.1 | 3.0 | 1.6 |
| | Level | 3.6 | 6.8 | 4.8 | 5.5 | 1.8 | 2.2 | 1.9 |
| | Low | 4.7 | 8.2 | 5.4 | 4.9 | 2.3 | 3.3 | 2.2 |



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ANALYSIS OF B-29 LOSSES TO ENEMY ACTION

XX Bomber Command, Missions 1-27

The following tabulation is based on 25 A/C lost. When one A/C is lost as a result of the combination of two causes, it is tallied under both causes. For this reason a total of 33 cases are listed.

| Cause of Loss | Direction of Attack | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Azimuth | | | | | | |
| | | Nose | | | Tail | All Other | Unknown | |
| | Elevation | 11 | 12 | 2 | 6 | | | |
| E/A Guns (17 losses) | High | 2 | 2 | 2 | 0 | 0 | 0 | 6 |
| | Level | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Low | 1 | 0 | 1 | 0 | 0 | 1 | 3 |
| | Unknown | 1 | 2 | 0 | 0 | 0 | 5 | 8 |
| | Total | 4 | 4 | 3 | 0 | 0 | 6 | 17 |
| E/A Bombs (3 losses) | High | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| | Level | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Low | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Unknown | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | Total | 0 | 2 | 0 | 0 | 0 | 1 | 3 |
| Ramming by E/A (5 losses) | High | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| | Level | 1 | 2 | 0 | 0 | 0 | 0 | 3 |
| | Low | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Unknown | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 1 | 3 | 0 | 1 | 0 | 0 | 5 |
| Total Losses to E/A (24 losses) | High | 2 | 5 | 2 | 1 | 0 | 0 | 10 |
| | Level | 1 | 2 | 0 | 0 | 0 | 0 | 3 |
| | Low | 1 | 0 | 1 | 0 | 0 | 1 | 3 |
| | Unknown | 1 | 2 | 0 | 0 | 0 | 6 | 9 |
| | Total | 5 | 9 | 3 | 1 | 0 | 7 | 25 |

Losses from causes other than E/A: Ground Attacks 2
Flak 4
Unknown 2

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INTERCOM PROCEDURES AND NOMENCLATURE FOR THE ALLOCATION OF TURRETS AMONG GUNNERS

Extracted from XX Bomber Command Tactical Doctrine
15 January, 1945

A. "DEFENSE DISCIPLINE"

1. Target Reporting.

a. Targets (enemy aircraft) and friendly aircraft will be reported by interphone. It is imperative that these reports be rendered clearly and concisely with careful attention being given to voice enunciation and volume. No information other than that contained in the prescribed report is required except under unusual circumstances.

b. There are two basic conditions under which targets and friendly aircraft must be reported. A different report is rendered for each of those conditions as follows:

(1) Condition I: When aircraft have been sighted during overtake or after they are in position to initiate an attack:

(a) There will be three parts to the target report; there will be a difinite pause or break between each part.

1. The first part will consist of two words indicating the number of aircraft reported and whether the aircraft reported is a friendly aircraft. The number of aircraft will be stated as "Ten" and "TWENTY-FIVE" rather than as "one zero" and "two five". The second word will be "FRIENDLY" if the aircraft reported is friendly. If a target, the second word will identify the aircraft by words such as "TOJO" or "ZEKE." If identification cannot be made the second word will simply indicate the type of enemy aircraft such as "fighter" or "twin engine fighter."

2. The second part will consist of two phases which will locate the aircraft reported in azimuth and elevation with respect to the bomber. The first phase will provide the azimuth position utilizing the clock system; the nose and tail of the bomber are the twelve and six o'clock positions, respectively. Whole numbers only will be used and will be spoken as "SEVEN O'CLOCK" and "TWELVE O'CLOCK." The second phase will indicate the elevation position of the aircraft reported with respect to the horizontal plane of the bomber and will be either "HIGH," "LOW," or "LEVEL."

3. The third part will be given only when the aircraft reported is a target and will indicate in one or two words the type of operation the target is conducting, for example, "CLIMBING," "OVERTAKING," "IN POSITION," or "MANEUVERING," etc.



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(b) The report will be repeated. Samples of reports to be rendered under Condition I are as follows:

1. " TEN HAPS ONE O'CLOCK LOW IN POSITION"
" TEN HAPS ONE O'CLOCK LOW IN POSITION"

2. "SIX TOJOS EIGHT O'CLOCK HIGH OVERTAKING"
"SIX TOJOS EIGHT O'CLOCK HIGH OVERTAKING"

(c) The gunner responsible for the area in which the target is, will acknowledge the target report by use of the words:

"MARK" "MARK"

If he fails to see them he will ask:

"WHERE ARE THEY?" "WHERE ARE THEY?"

In this case the person reporting the target will describe its location with greater detail.

(2) Condition II: When enemy aircraft are in the process of attacking:

(a) There will be only two parts to the target report: There will be a definite pause or break between each part.

1. The first part will consist of the word "ATTACK" which will indicate that an attack is in progress.

2. The second part will consist of the words which will locate the aircraft reported as in the second part of the report under Condition I, above.

(b) The report will be repeated. Samples of reports to be rendered under Condition II are as follows:

1. "ATTACK---THREE O'CLOCK HIGH"
"ATTACK---THREE O'CLOCK HIGH"

2. "ATTACK---ELEVEN O'CLOCK HIGH"
"ATTACK---ELEVEN O'CLOCK HIGH"

2. General:

a. Once a fighter has been reported by one crew member it will not be re-reported by other crew members unless it has committed itself to an attack or has entered the coverage area of another gunner.

b. Fighters that have made a definite breakaway will not be reported since they are no longer dangerous nor potential targets until they are again on the "overtake" and "in position," or "attack" phase.

c. "Slide unders," i.e., passes in which the enemy fighter immediately positions himself for another attack, must not be mistaken for breakaways and will be reported from one blister gunner to the other by merely reporting "Attacking Low 4 o'clock, etc., on the interphone.

d. Crew members will not give their name in reporting a fighter.



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B. "TURRET ALLOCATION"

1. There are thirty-six posible combinations between turrets and sighting stations in the B-29 RCT System. Of this total, six distinct combinations, each having a right and left phase, have been selected to produce optimum defensive fire under any condition. Figure 1 indicates each of these combinations in abbreviated chart form. Each of these turret-sighting station combinations is designated by a descriptive name; this name will be utilized in all matters pertaining to the allocation and transfer of B-29 RCT System turret control:

| | SIGHTING STATION | | | |
|---|---|---|---|---|
| COMBINATION | NOSE | TOP | LEFT SIDE | RIGHT SIDE |
| HI MAN LEFT | LF | UA,UF | LA | -- |
| HI MAN RIGHT | LF | UA,UF | -- | LA |
| NOSE OUT LEFT | -- | UA,UF | LA | LF |
| NOSE OUT RIGHT | -- | UA,UF | LF | LA |
| PRIMARY LEFT | UF,LF | UA | LA | -- |
| PRIMARY RIGHT | UF,LF | UA | -- | LA |
| BROADSIDE LEFT | -- | UA,UF | LA,LF | -- |
| BROADSIDE RIGHT | -- | UA,UF | -- | LA,LF |
| ONE EACH LEFT | UF | UA | LA | LF |
| ONE EACH RIGHT | UF | UA | LF | LA |
| GANG LOW LEFT | UF | UA | LA,LF | -- |
| GANG LOW RIGHT | UF | UA | -- | LA,LF |

LEGEND

UF Upper Forward Turret
UA Upper Aft Turret
LF Lower Forward Turret
LA Lower Aft Turret
T Tail Turret

Tail Gunners will control tail turret at all times.

FIGURE I.

2. It is important to distinguish between the words primary control, secondary control, and initial control.

a. Primary control is that feature of the B-29 RCT System which permits the nose gunner to secure control of the upper forward turret and the lower forward turret and the tail gunner to secure control of the tail turret by switching their transfer switches to "in" and closing their action switches.

b. Secondary control refers to any other turret control other than primary control.

c. Initial control is the allocation agreed upon as the standard one for defense of the plane or element. The circumstances under which deviation is made from initial control, are listed in the Standard Operating Procedure for Search and Fire Coverage. In the present plan for formation defense, the initial control is "Hi Man."



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3. The justification for the use of the descriptive names is as follows below. In each case the description refers to the left phase. The words pertaining to the right phase are in parenthesis.

a. HI MAN LEFT (RIGHT).

(1) The words "hi man" refer to the top gunner who operates both upper turrets as a gang; the word "left (right)" denotes which side gunner will control the lower aft turret.

(2) Strong fire power can be delivered in the upper hemisphere.

b. NOSE OUT LEFT (RIGHT).

(1) The words "nose out" indicate that no turrets are under the control of the nose gunner; the word "left (right)" designates which side gunner has control over the lower aft turret. The other side gunner will have control of the lower forward turret.

(2) This allocation of turrets is primarily for the bombing run. Maximum fire power can be delivered to the rear.

c. PRIMARY LEFT (RIGHT).

(1) The word "primary" denotes the use of the established system of turret control; the word "left (right)" refers only to the sighting station controlling the lower aft turret.

(2) Strong fire power can be delivered in the high forward zones and low and level in the forward quarter on the left (right) side.

d. BROADSIDE LEFT (RIGHT).

(1) The word "broadside" allocates the control of both upper turrets to the top gunner and both lower turrets to a side gunner; the word "left (right)" specifies which side gunner will control both lower turrets. This is essentially a combination of "gang low" and "hi man."

(2) Strong fire power can be delivered in the left (right) rear quarter.

e. ONE EACH LEFT (RIGHT).

(1) The words "one each" indicate that each sighting station is assigned control of one turret; the word "left (right)" determines which side sighting station has control of the lower aft turret.

(2) Strong fire power can be delivered in the left (right) tail quarter.

f. GANG LOW LEFT (RIGHT).

(1) The words "gang low" specify the operation of the two lower turrets as a gang, i.e., controlled by a single operation; the word "left (right)" determines which side sighting station has control of the lower turrets.

(2) Strong fire power can be delivered in the left (right) rear quarter.



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TACTICAL DOCTRINE ON FORMATION DEFENSE

Extracted from XX Bomber Command Tactical Doctrine, 15 January, 1945

C. "SEARCH AND FIRE COVERAGE"

1. Under normal circumstances the "Hi-man" system of turret control will be used by the combat crews during combat missions. The allocation of turret control to combat crew members using the "Hi-man" system is as follows:

a. Bombardier controls lower forward turret.

b. Top gunner controls the two top turrets.

c. Side gunners control the lower aft turret.

d. Tail gunner controls the tail turret.

2. The "Hi-man" system of turret control whereby the top gunner instead of the bombardier controls the upper forward turret is considered to be the best arrangement for the following reasons:

a. The top gunner is better able to counter enemy attacks from the upper forward zone than the bombardier because he has better visibility in that area and he also has better control of his sight when firing into that zone.

b. The top gunner can utilize the upper forward turret to counter attacks from the upper rear area.

c. When the bombardier is controlling both forward turrets he can only fire one turret at a time, therefore, during a coordinated high and low attack he could only fire at one of the attacking planes, thus rendering one of the turrets in his control useless.

d. The bombardier can always obtain control of the upper forward turret simply by switching the transfer switch. He might take control when a coordinated high frontal attack is made or a level frontal attack by a single enemy aircraft is made.

3. The basic "Hi-man" allocation of turrets will be changed under one or more of the following circumstances:

a. During the bomb run when it becomes necessary for the bombardiers to concentrate on dropping their bombs each bombardier will switch his transfer switch for the lower forward turret to the out position and say over the interphone "Nose Out." The blister gunners will then extend their search and fire coverage to protect the lower forward areas. Following bomb release and the closing of the bomb bay doors, the bombardier will resume control of the lower forward turret.

b. When a sighting station having control over a turret is neutralized due to material damage or a gunner casualty.

c. When a shift in formation is made.

d. During a coordinated fighter attack when it is necessary to have only one turret controlled by any one station in order that fire can be brought to bear against each approaching fighter if there is sufficient time to accomplish the transfer safely.

The potentialities of transferring control to give added protection to the formation have barely been touched. An example of a situation involving such a transfer is as

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follows: During the overtaking or in position phase of a coordinated high frontal attack the bombardier will take control of the upper forward turret. He will fire at the second fighter coming in and the top gunner will fire at the first attacking fighter. As we learn more of enemy tactics and become more experienced in interplane and inter-element coordination, the effectiveness of our defense may reach a degree previously unattainable.

4. Any gunner can fire at a target outside his area of seach providing:

a. The target is reported as attacking or threatening.

b. The target is in range and in the field of his guns.

c. There is no threatening targets in his area of search.

d. He exercises extreme caution to avoid damaging other airplanes in his formation.

e. He announces over the interphone who he is and the position of the attack at which he will fire. For instance, "Top to attack 5 o'clock high."

f. As soon as the attack is completed he immediately returns to his assigned area.

Other members of the crew not engaged in countering an attack will attempt to search the area assigned to the gunner who is firing at a target outside his area.

5. To provide adequate protection against surprise attacks from the sun, the gunner covering the section containing the sun will be responsible to see that the region around the sun is searched intensively. He will coordinate with other crew members who can also conveniently see the sun, taking turns with him so that no crew member will suffer extreme eye strain. The other crew members must extend their search to cover the sun area.

6. The following allocation of areas of search has been designed to reduce the strain on the gunners to a minimum, achieve complete coverage of the space surrounding the formation and conform as closely as possible to the limitations of the sighting stations. This allocation is based on an element plane for the defense of the formation as a whole. The defensive fire power of the elements is pooled to protect the entire formation. The allocation of the areas of search for the combat crew members depends upon whether there are one, two, or three planes in the element even though the element is contained in a larger formation:

Three Plane Element

| Plane | Combination | Assigned Areas of Search | | | | |
|---|---|---|---|---|---|---|
| | | Nose | Top | RB | LB | |
| 1 (lead) | hi man right (or left) | 10-2 | 9-3 | 2-6* | 6-10 | High<br>Low |
| 2 (right wing) | hi man right | 10-2 | 12-6 | 2-6* | 6-10 | High<br>Low |
| 3 (left wing) | hi man left | 10-2 | 6-12 | 2-6 | 6-10* | High<br>Low |

The Tail Gunner will search the entire region covered by his guns.
* Indicates control of the Lower Aft Turret.



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In the event the element is incomplete and contains only two planes then the following will be the search areas of the gunners:

Two Plane Element

| Plane | Combination | Assigned Areas of Search | | | | |
|---|---|---|---|---|---|---|
| | | Nose | Top | RB | LB | |
| 1 (lead) | hi man left (or right) | 10-2 | 9-3 | 2-6 | 6-10* | High<br>Low |
| 2 (right) | hi man right (or 3 left then hi man left) | 10-2 | 3-9 | 2-6* | 6-10 | High<br>Low |

In the event the element consists of a single plane then the following will be the assigned areas of search:

| Combination | Assigned Areas of Search | | | | |
|---|---|---|---|---|---|
| | Nose | Top | RB | LB | |
| hi man right (or left) | 10-2 | 9-3 | 5-4<br>2-6* | 8-9<br>6-10 | High<br>Low |

The tail gunner will extend his high search area to cover from 4 to 8.

D. "EVASIVE ACTION"

A bomber or formation of bombers may execute evasive action under the following circumstances:

1. To avoid flak damage - Evasive action to avoid flak can be accomplished at the discretion of the formation leader in the case of a formation or the airplane commander in the case of a single airplane.

2. To spoil the aim of attacking fighters - Evasive action to spoil the aim of attacking fighters should only be taken in the case of a small formation or a single aircraft. The only attack against which evasive action is considered effective is the frontal attack in which case the best procedure is to turn away from the attack. When in formation all evasive action will be initiated by the formation leader.

3. To increase fire effectiveness in a particular zone - A condition may arise when it would be desirable to shift the airplanes in an element or a formation to meet the threat of fighters on one side of the formation or to prepare for a potential threat on one side of the formation. The action taken, at the discretion of the formation leader, is to shift wing airplanes so as to stack the formation and bring the maximum number of guns to bear on a particular area.

4. To avoid collision with an uncontrolled enemy aircraft - The emergency situation may occur in which an enemy aircraft is out of control after being hit by fire from the formation and continues travelling in the direction of one or two of the aircraft in the formation. This is particularly dangerous when the target is approaching from the nose cone. The phrase "Ram-Ram" will be used by the bombardier or top gunner to inform the pilot or copilot of the approach of an uncontrolled aircraft from the front. The pilot or copilot will endeavor to drop or raise his aircraft to avoid the approaching aircraft.



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## Potential Instances of Own Formation Damage

Standard 12-Plane B-29 Formation, with Prescribed Briefing

1. Airplanes within Briefed Areas.

In numerous instances areas of search and fire as presently briefed include friendly airplanes within them. Since a purpose of briefing is to eliminate such possibilities of self-inflicted damage within the formation, these briefed areas should be altered to exclude friendly airplanes. The turrets for which this condition exists are the following:

| Airplane Number | Turret | Airplane Endangered |
|---|---|---|
| A-1 | Tail | C-2 |
| A-3 | U.A. | A-1 |
| C-1 | U.F. | C-2 |
| C-2 | U.F.,U.A. | B-2,B-3 |
| D-1 | U.F. | A-1 |
| | U.A. | A-1,A-3,D-3 |
| D-2 | U.F.,U.A. | B-2,B-3,C-2, C-3,D-3. |
| D-3 | L.F. | D-1 |

2. Insufficient Allowance for Deflections.

When firing at a target on the beam the deflection is ordinarily toward the tail, and may be large. Areas of search and fire should stop far enough ahead of friendly ships to allow for the difference in direction of guns and sight. Instances in which such allowance appears insufficient are:

| Airplane Number | Turret | Airplane Endangered |
|---|---|---|
| A-3 | L.A. | D-1 |
| C-3 | L.F. | D-1 |

3. Unduly restricted areas of fire.

The tail turret of airplane A-2 has been briefed to fire only above the horizon. No reason for this restriction is apparent.



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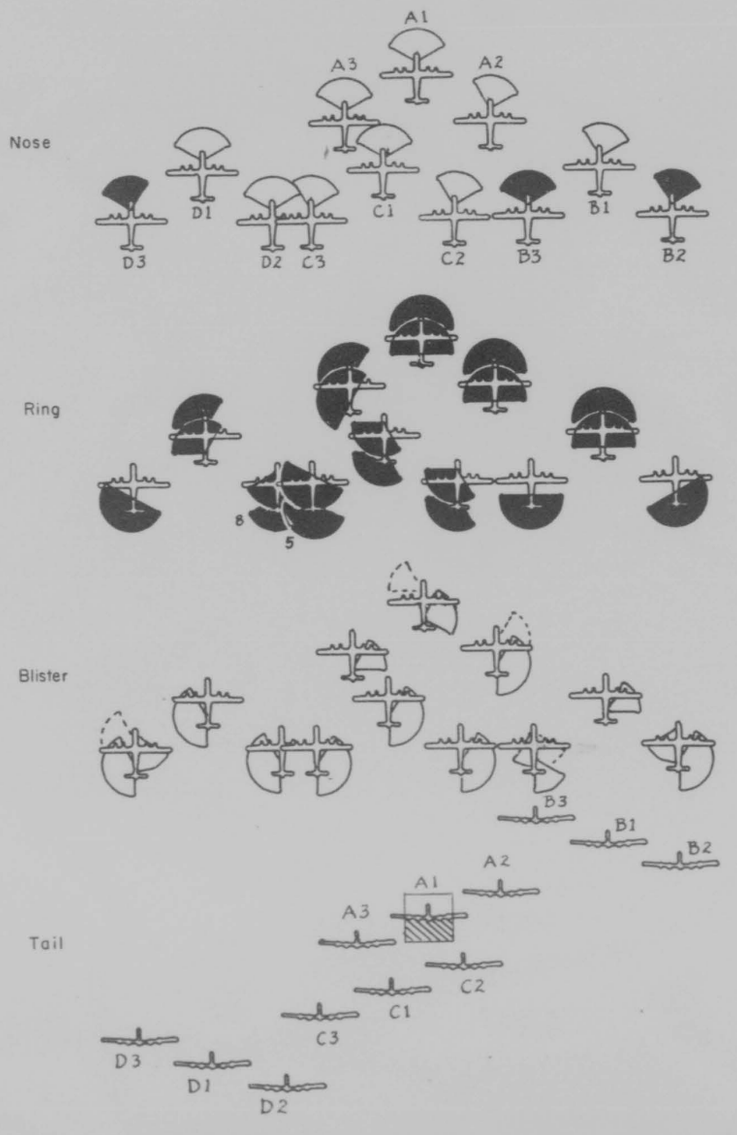
RECOMMENDED REBRIEFING

Standard 12-Plane Formation

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RECOMMENDED REBRIEFING OF THE STANDARD 12-PLANE FORMATION

| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring LA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | Center | HI MAN R F | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R F | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R F | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Center | HI MAN R F | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R A | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R A | -- | 11-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN R A | -- | 11-2 | 4-10 | 4-10 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L F | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L A | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |

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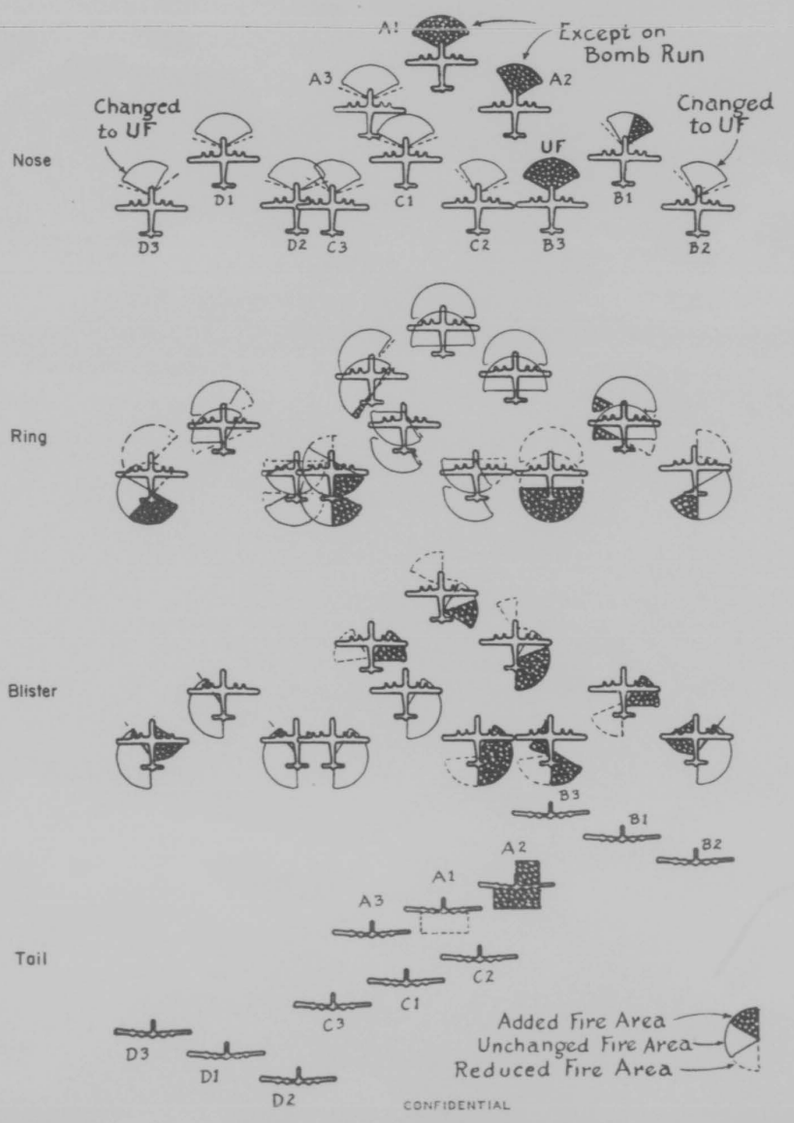
DIFFERENCE BETWEEN PRESCRIBED AND RECOMMENDED BRIEFING

12 - Plane Formation



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NUMBER OF GUNS BEARING AT VARIOUS POINTS OF THE SKY

REBRIEFED 12-PLANE FORMATION

| Clock Angle | High | Level | Low |
|---|---|---|---|
| 10 | 25 | 22 | 11 |
| 11 | 25 | 29 | 17 |
| 12 | 21 | 29 | 18 |
| 1 | 21 | 31 | 22 |
| 2 | 15 | 22 | 17 |
| 3 | 9 | 12 | 6 |
| 4 | 6 | 7 | 6 |
| 5 | 34 | 30 | 22 |
| 6 | 51 | 41 | 41 |
| 7 | 42 | 37 | 26 |
| 8 | 18 | 13 | 7 |
| 9 | 22 | 22 | 6 |





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PHOTOGRAPHIC ANALYSIS OF DEFENSIVE FIRE POWER
Standard 12-Plane Formation of B-29's
REVISED BRIEFING

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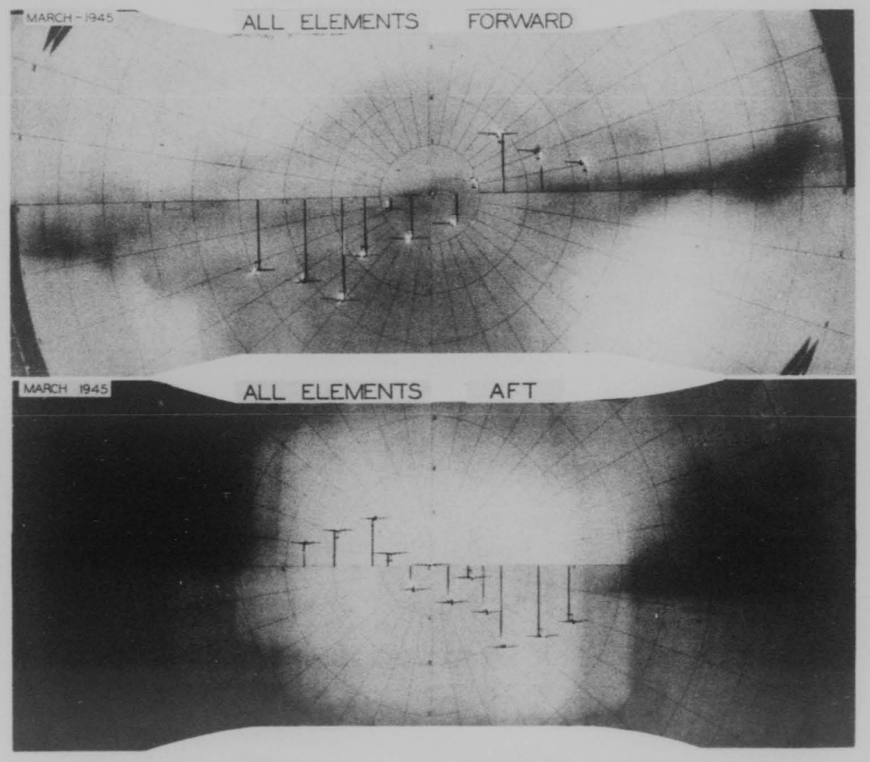




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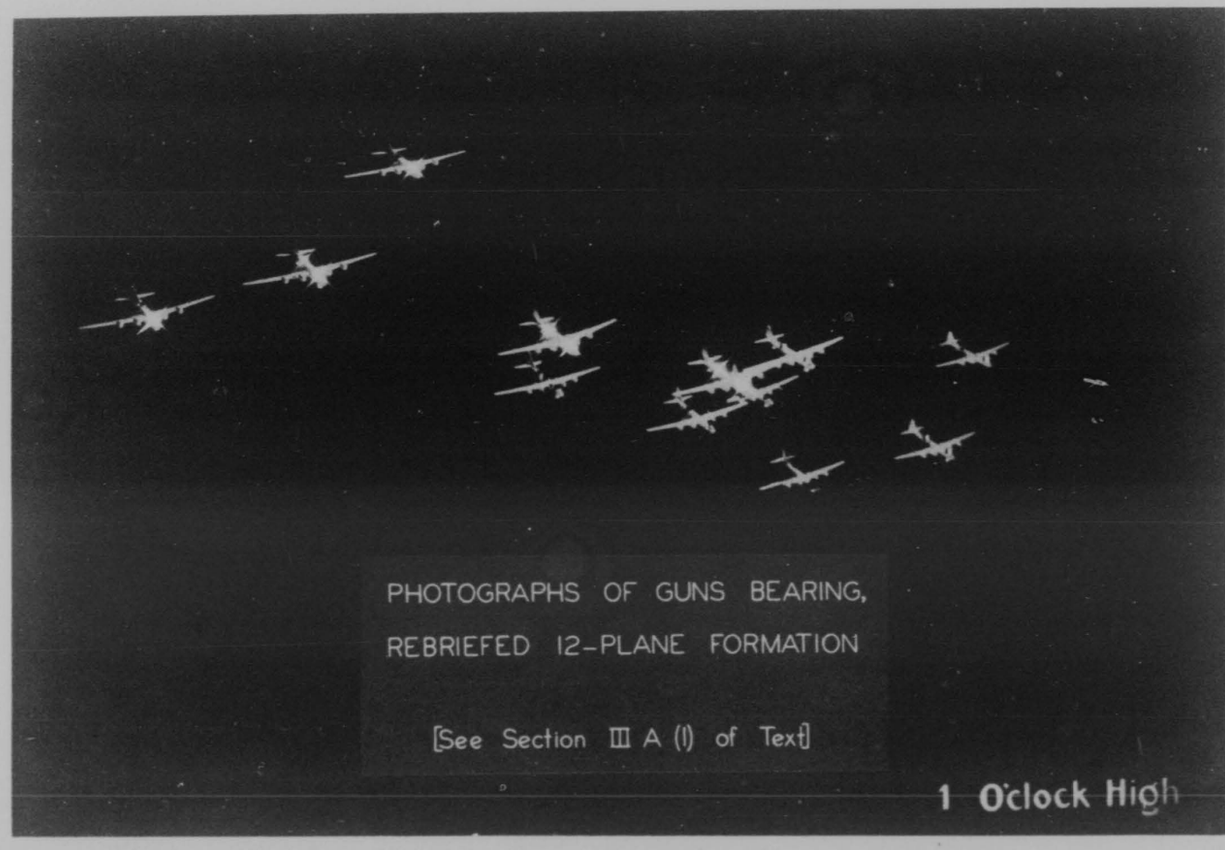

PHOTOGRAPHS OF GUNS BEARING,
REBRIEFED 12-PLANE FORMATION

[See Section III A (1) of Text]

1 O'clock High







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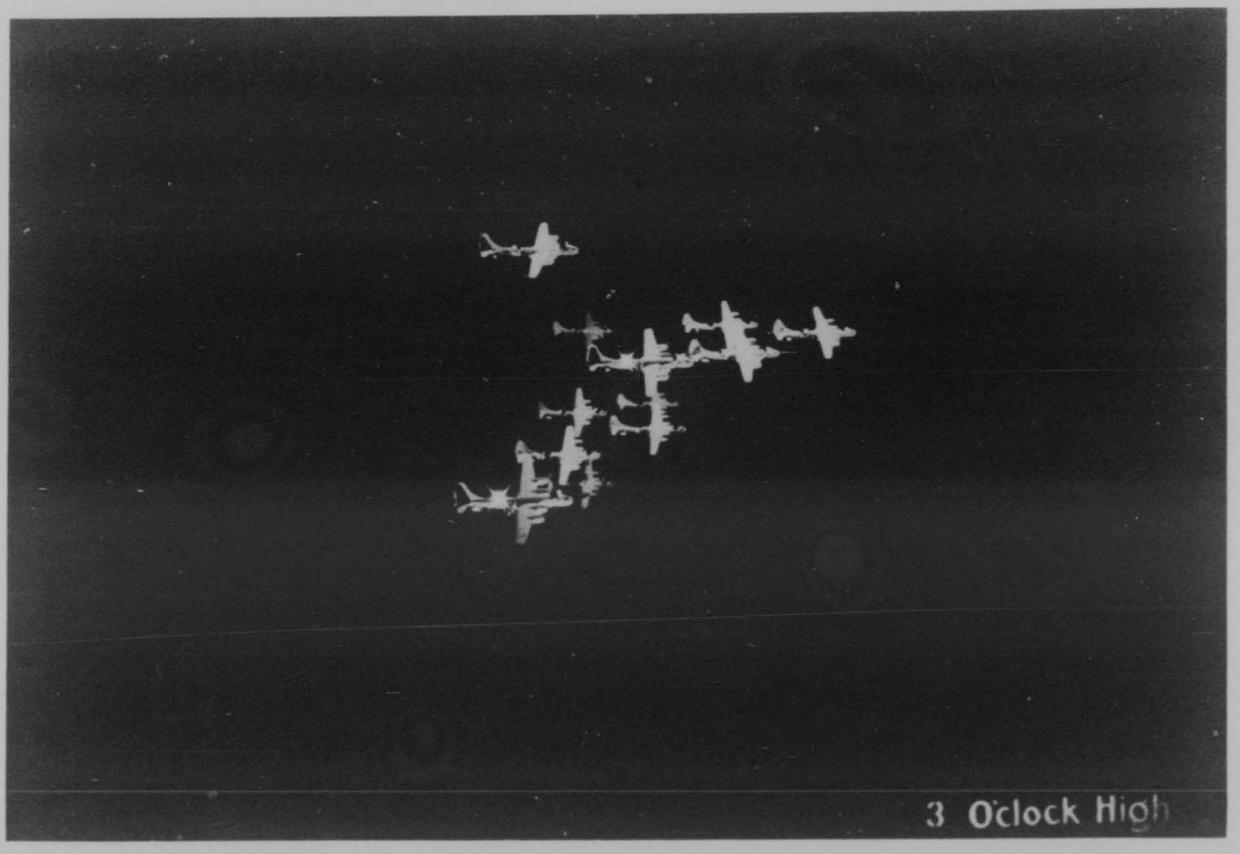








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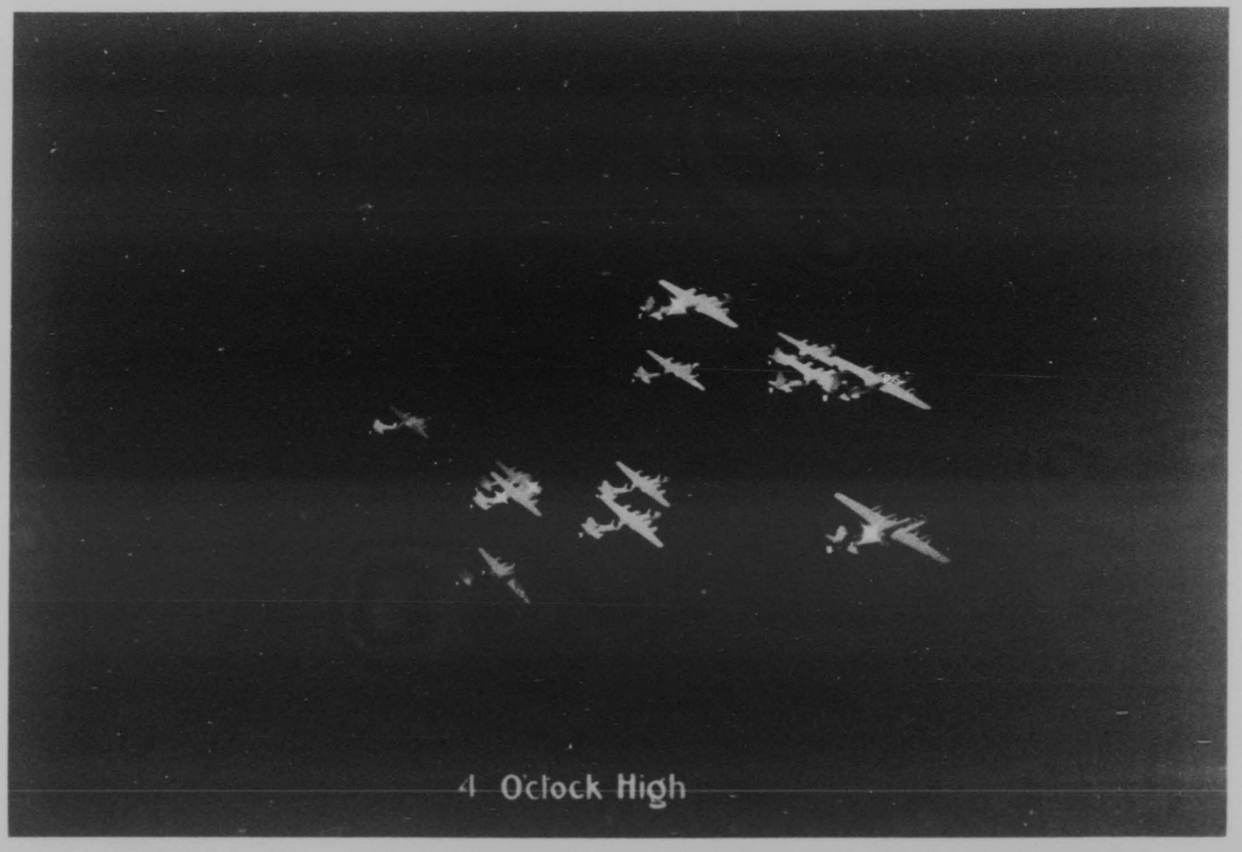


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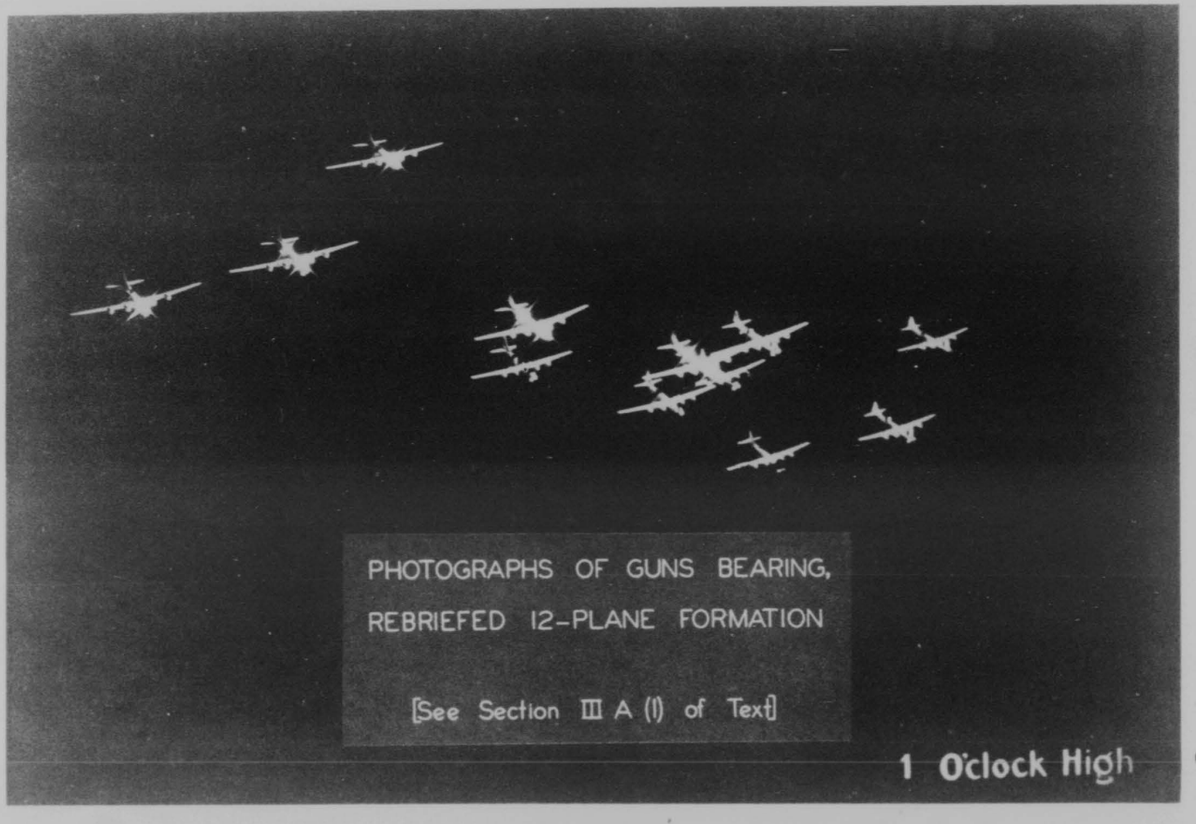

PHOTOGRAPHS OF GUNS BEARING,
REBRIEFED 12-PLANE FORMATION

[See Section III A (1) of Text]

1 O'clock High







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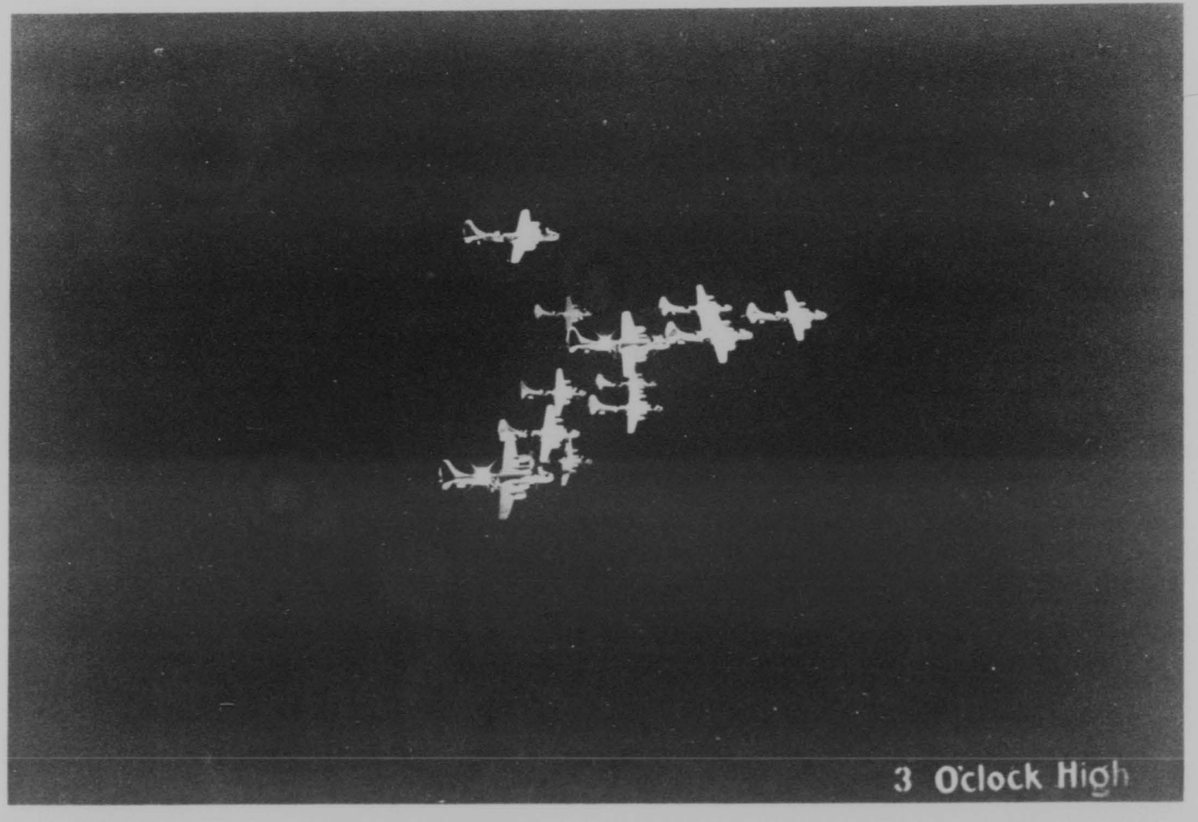


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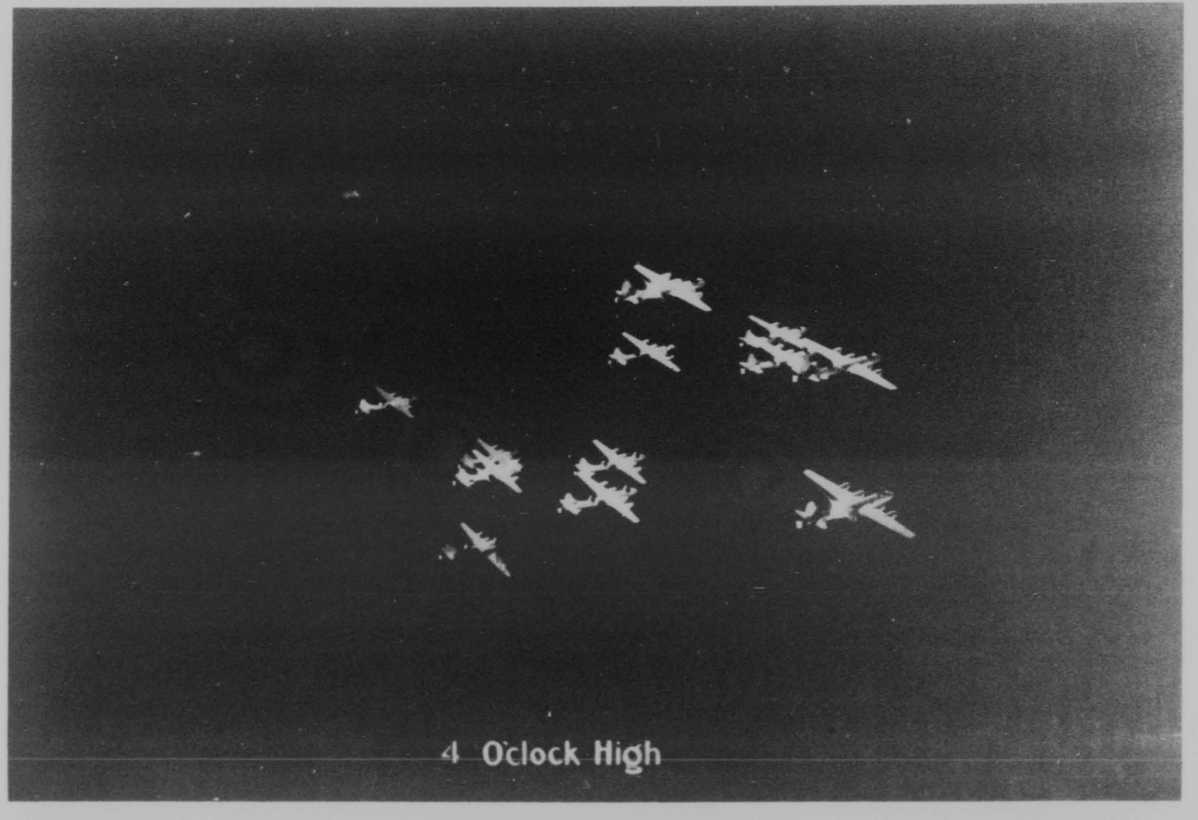


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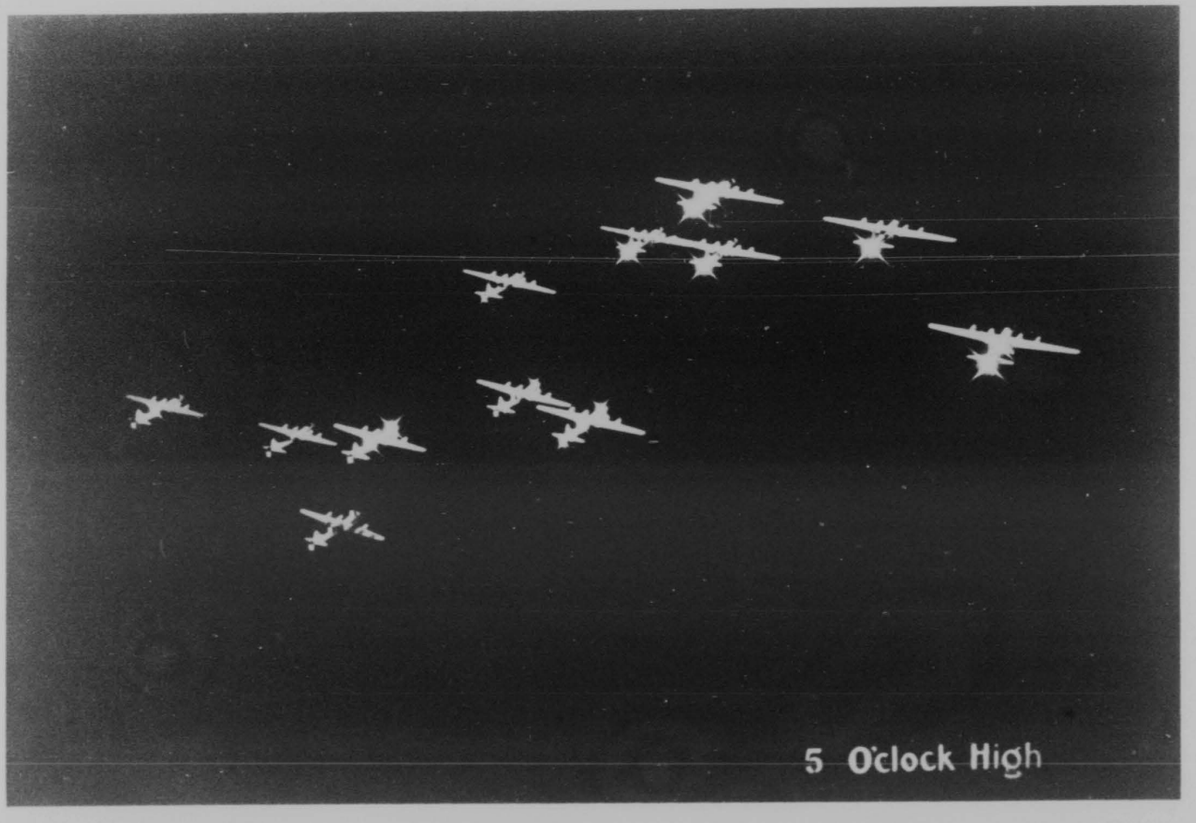


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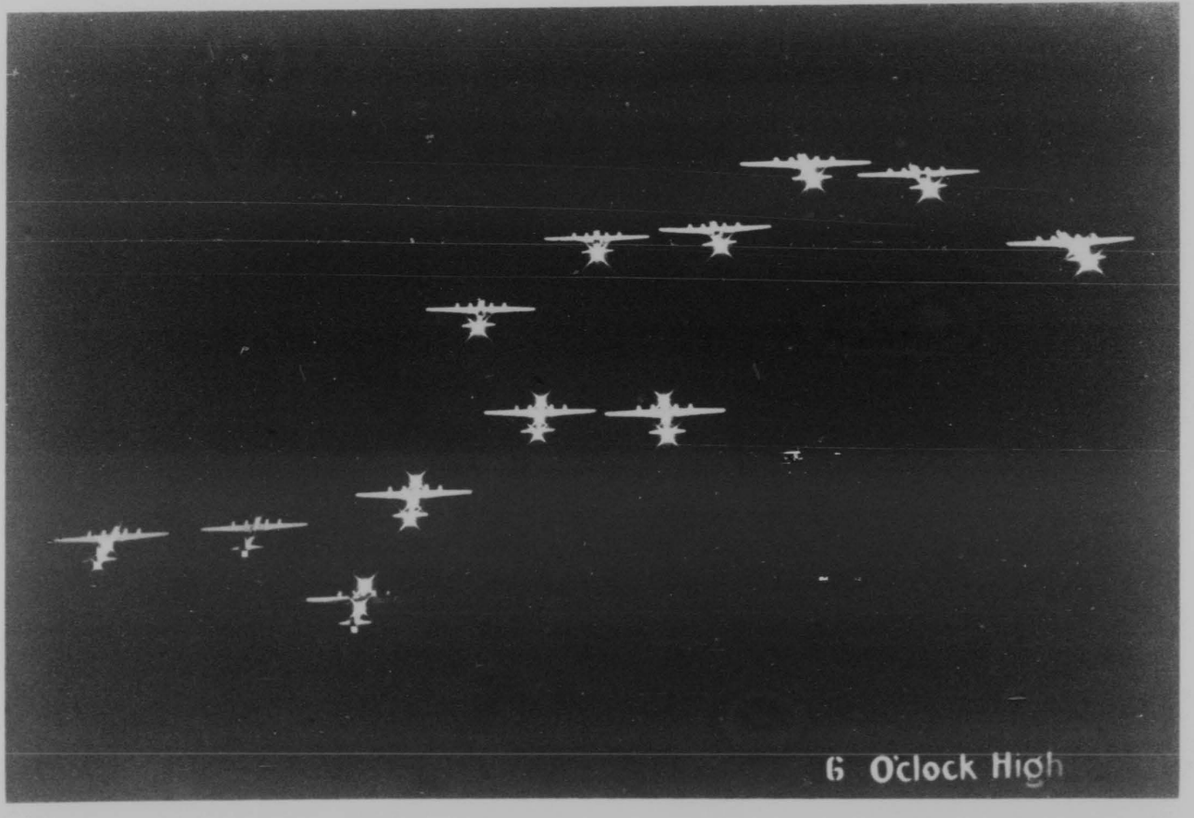


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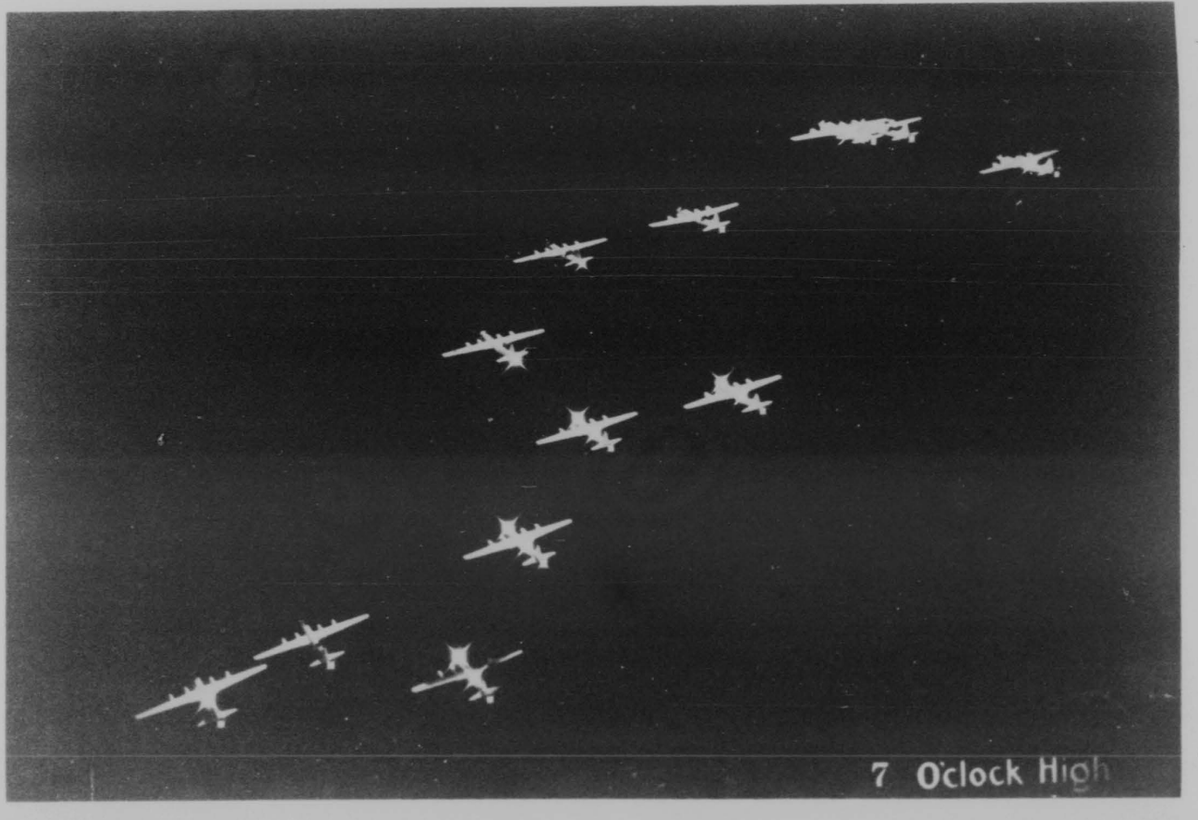










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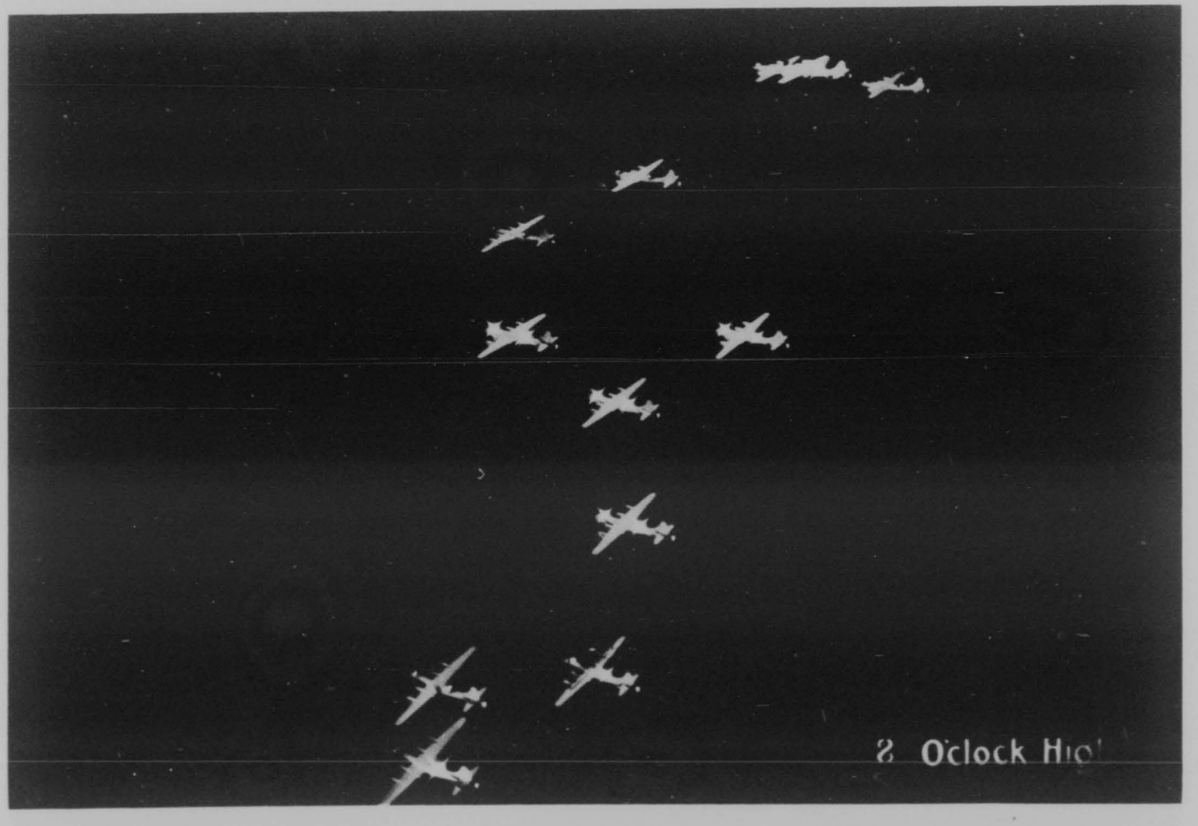


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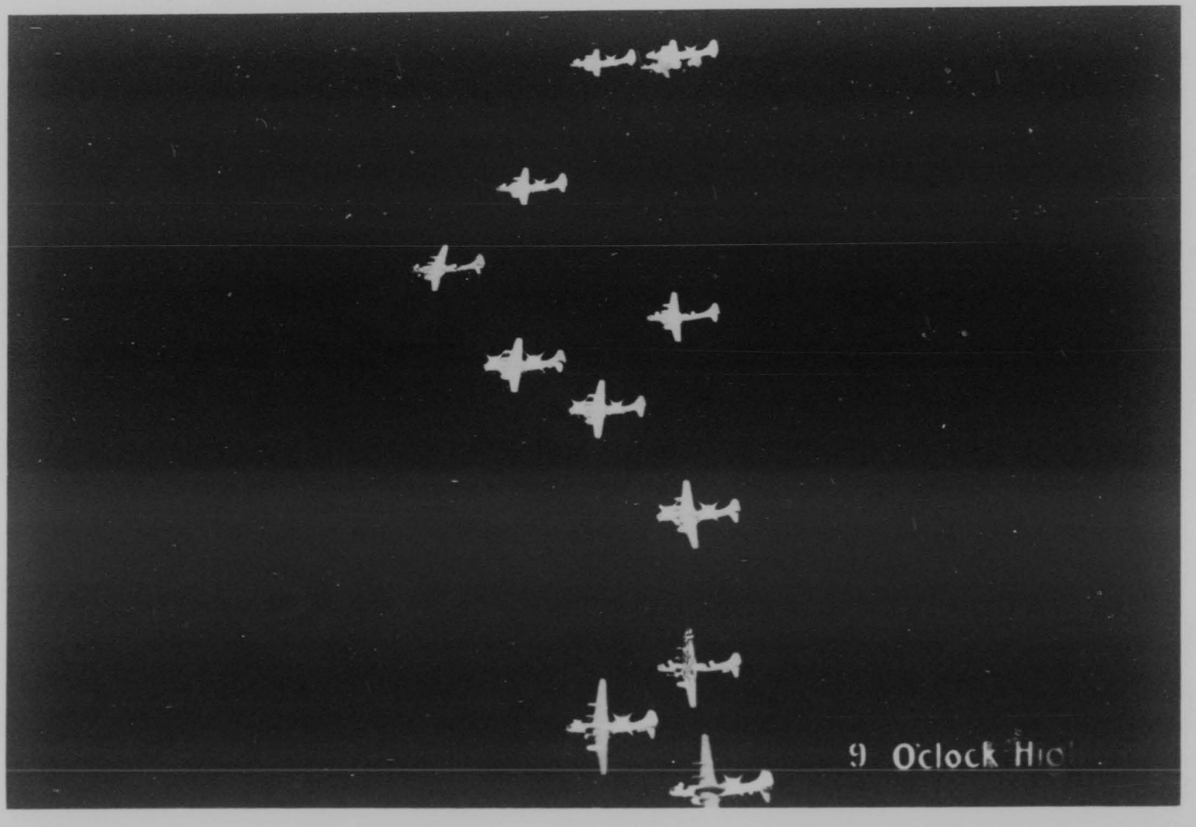


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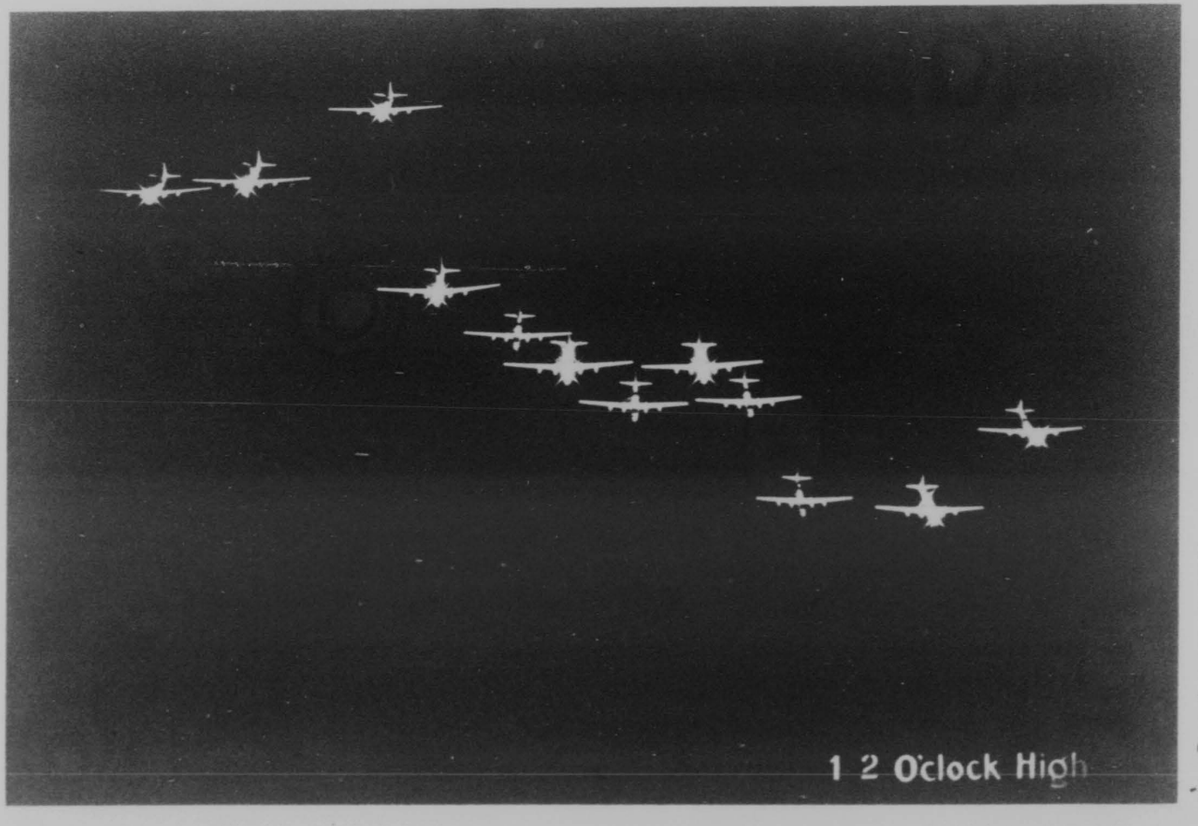










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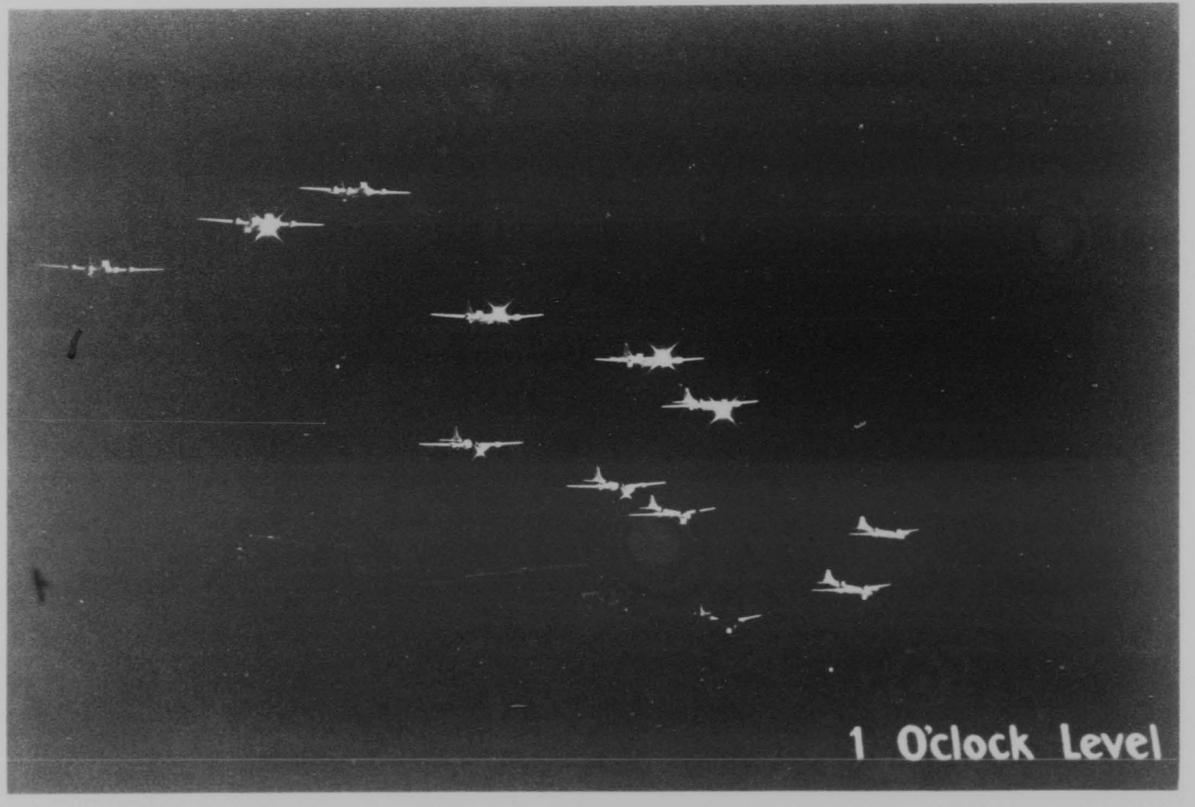










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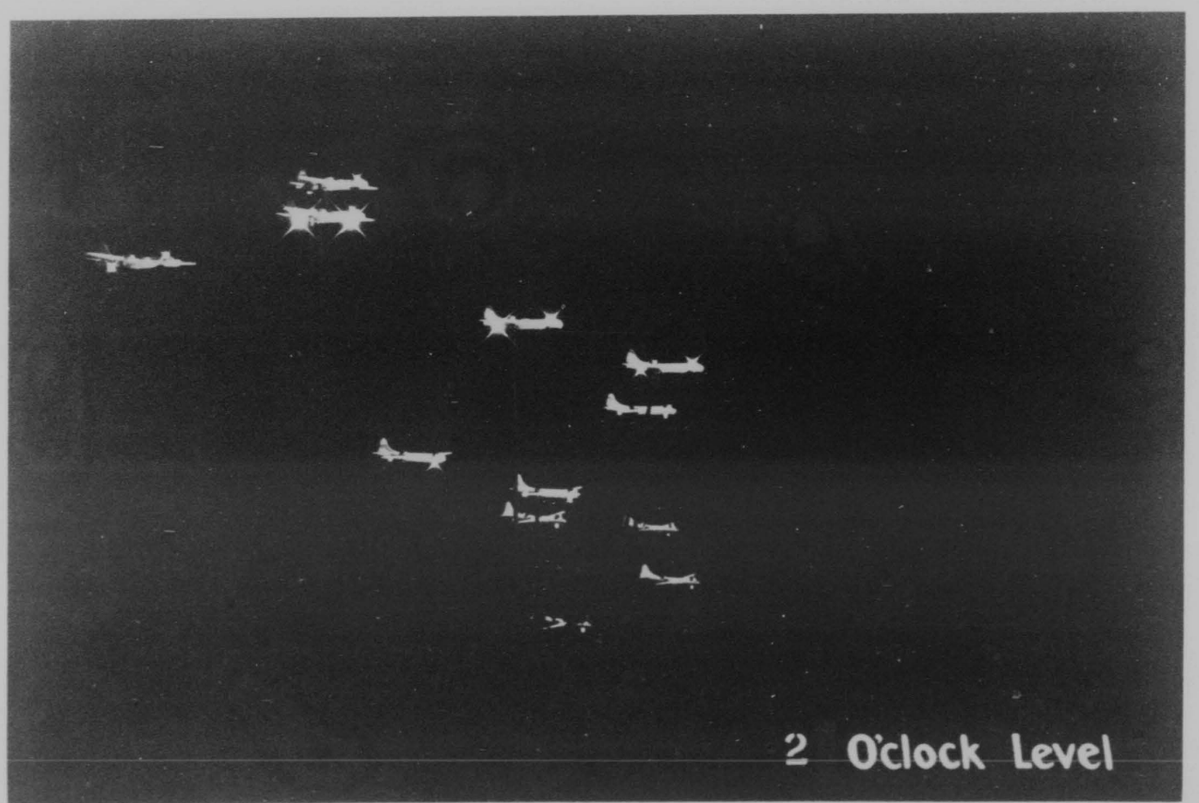


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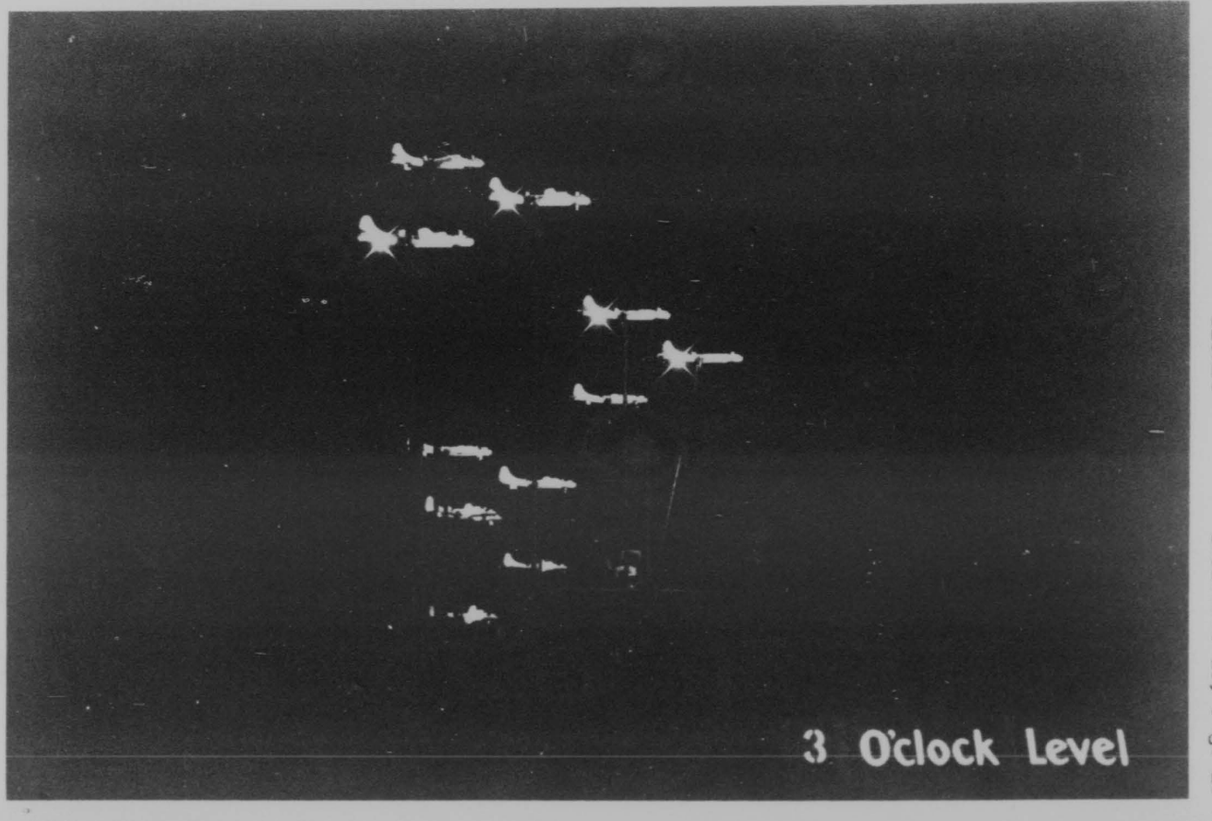


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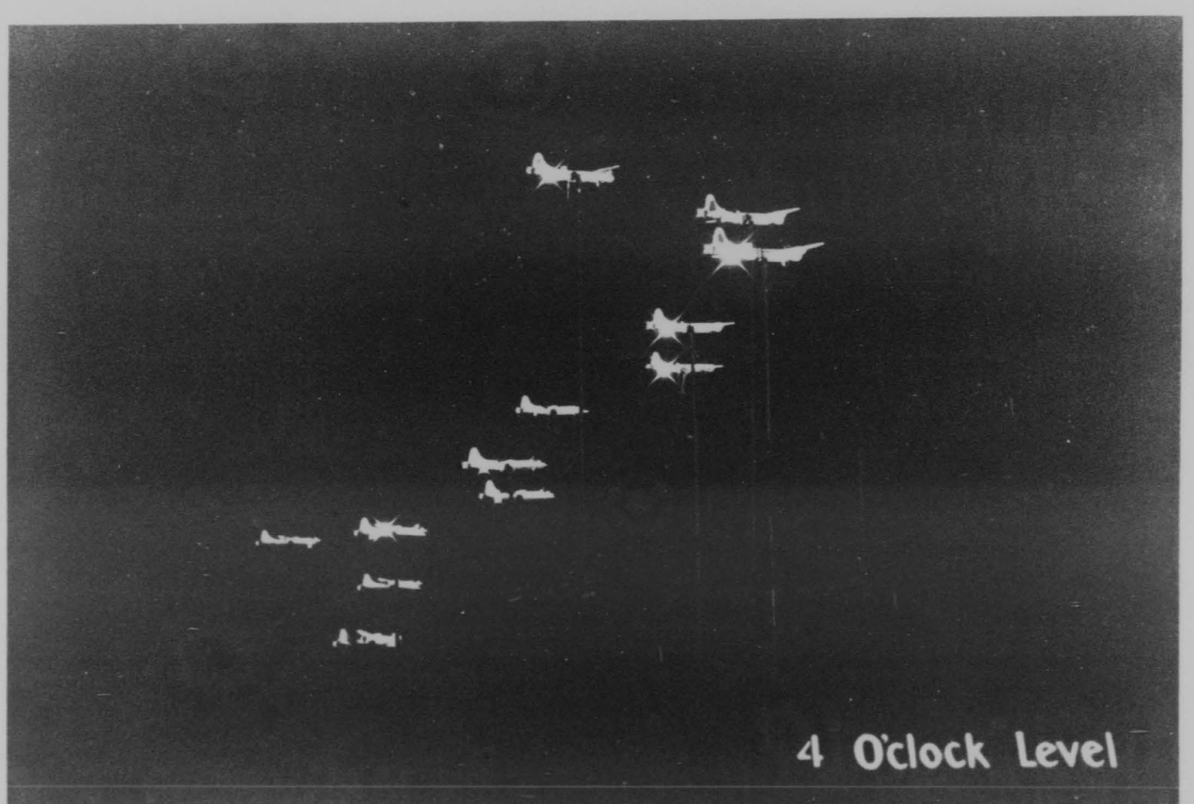








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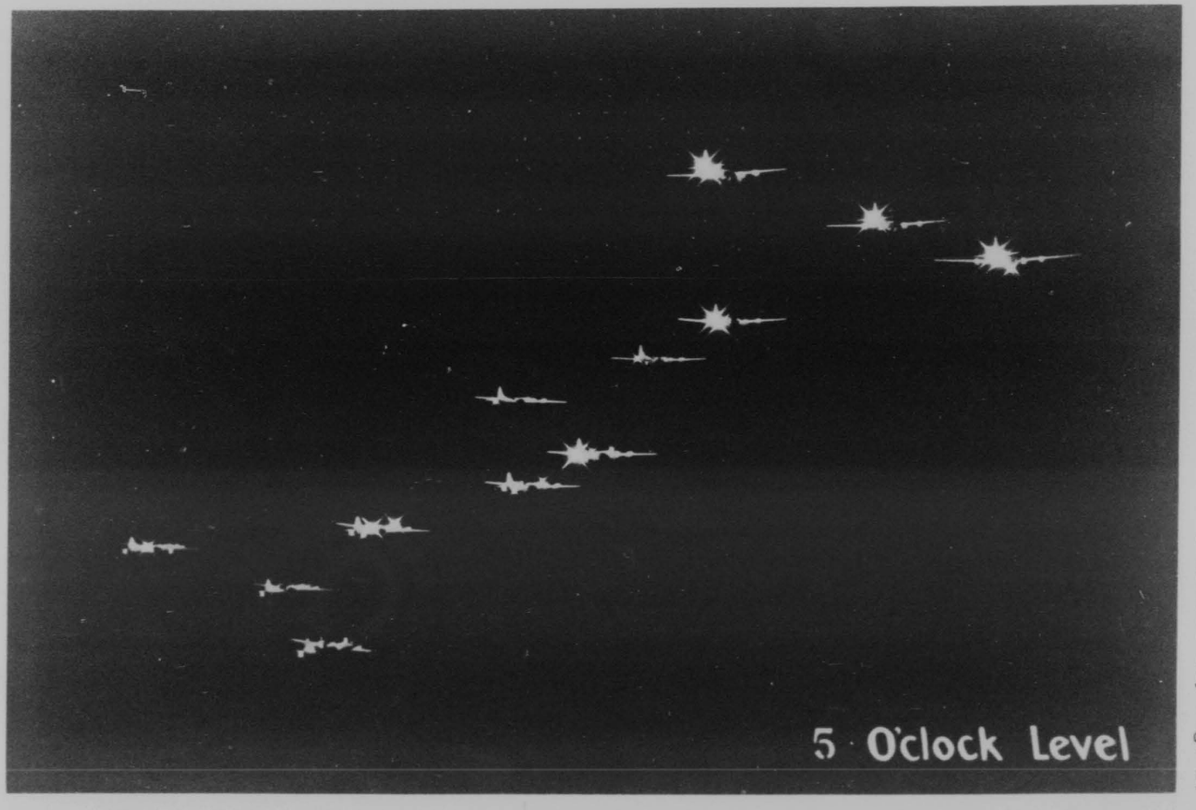


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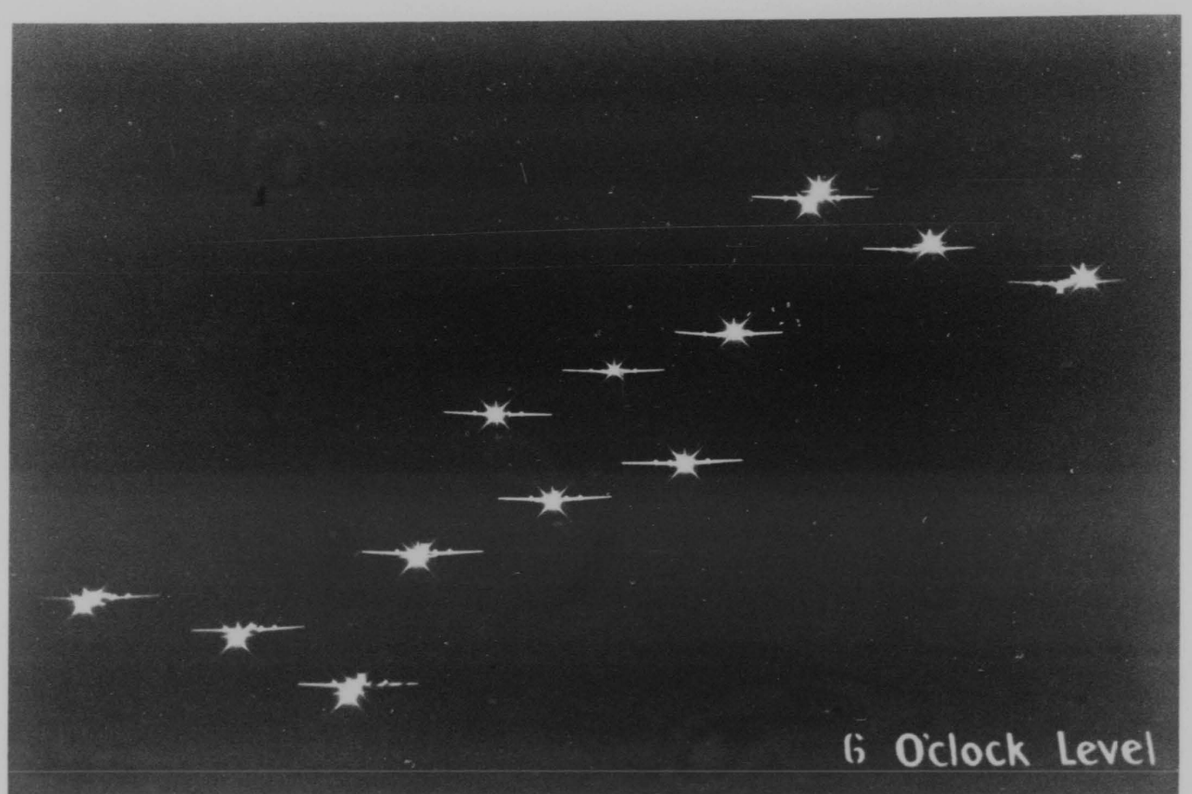


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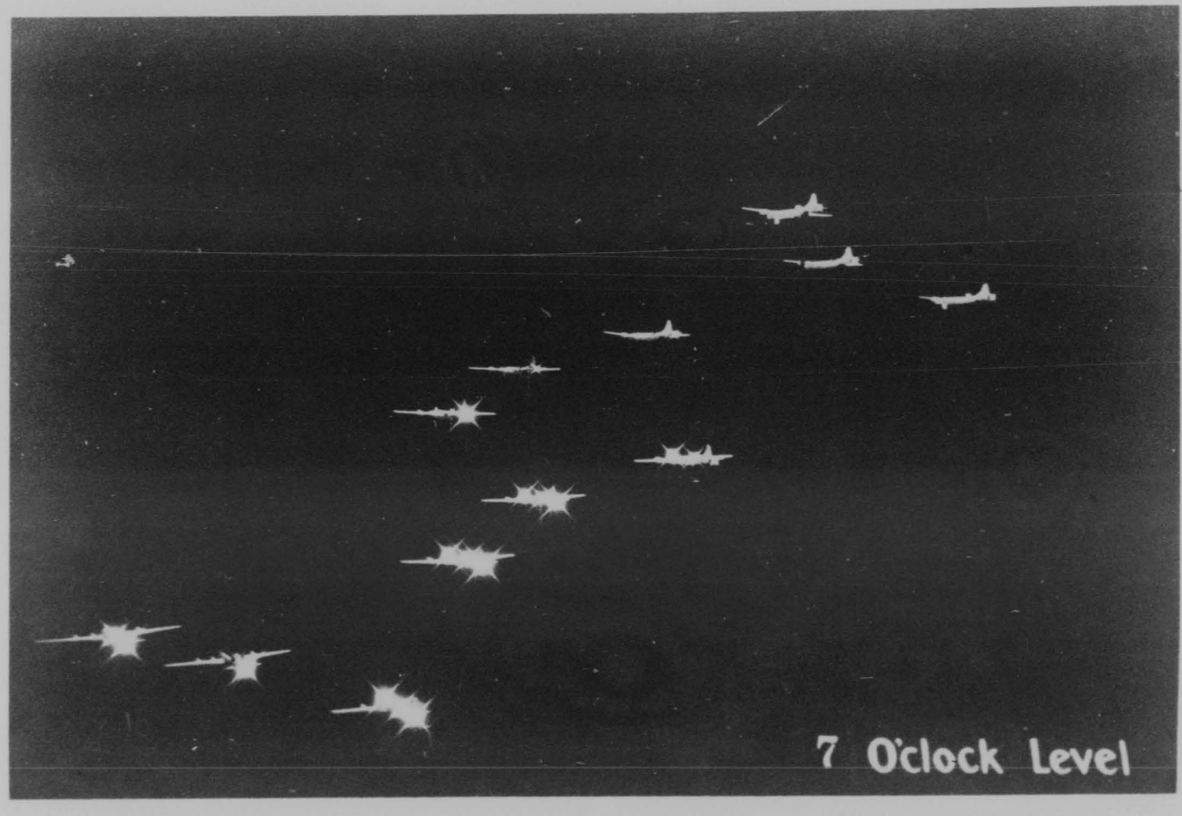


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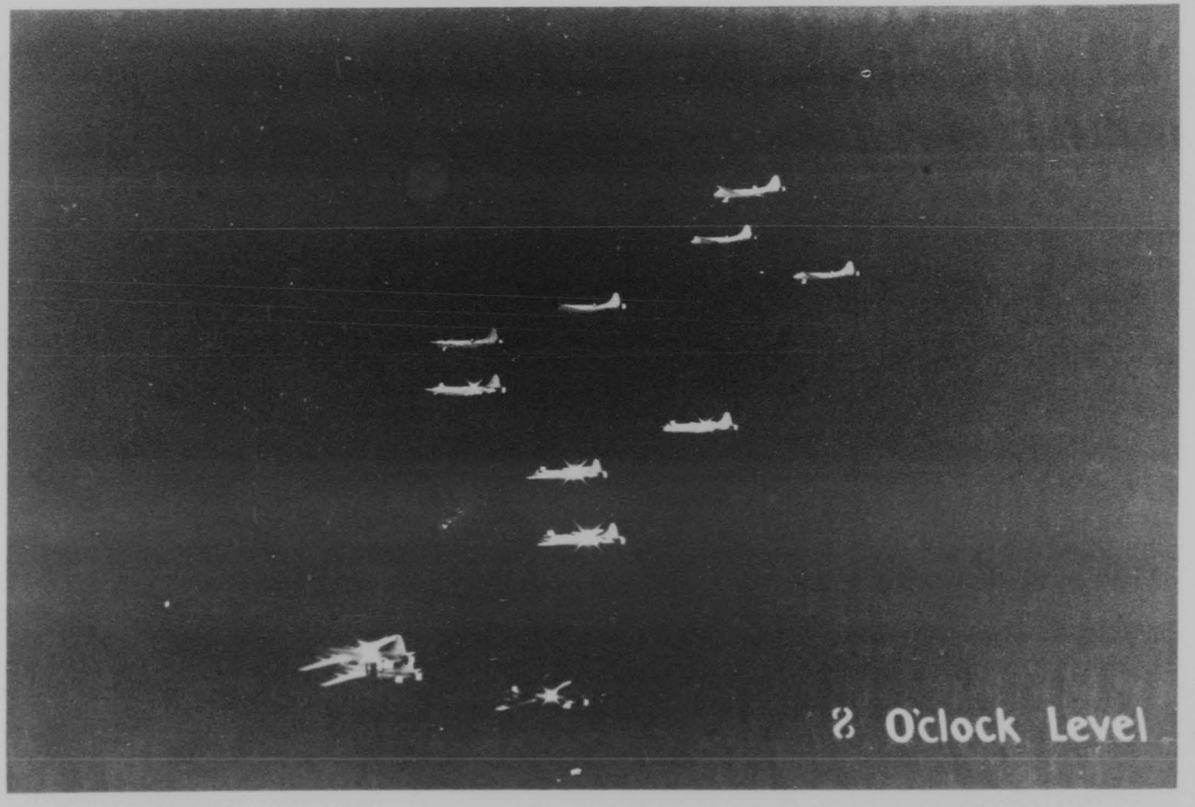


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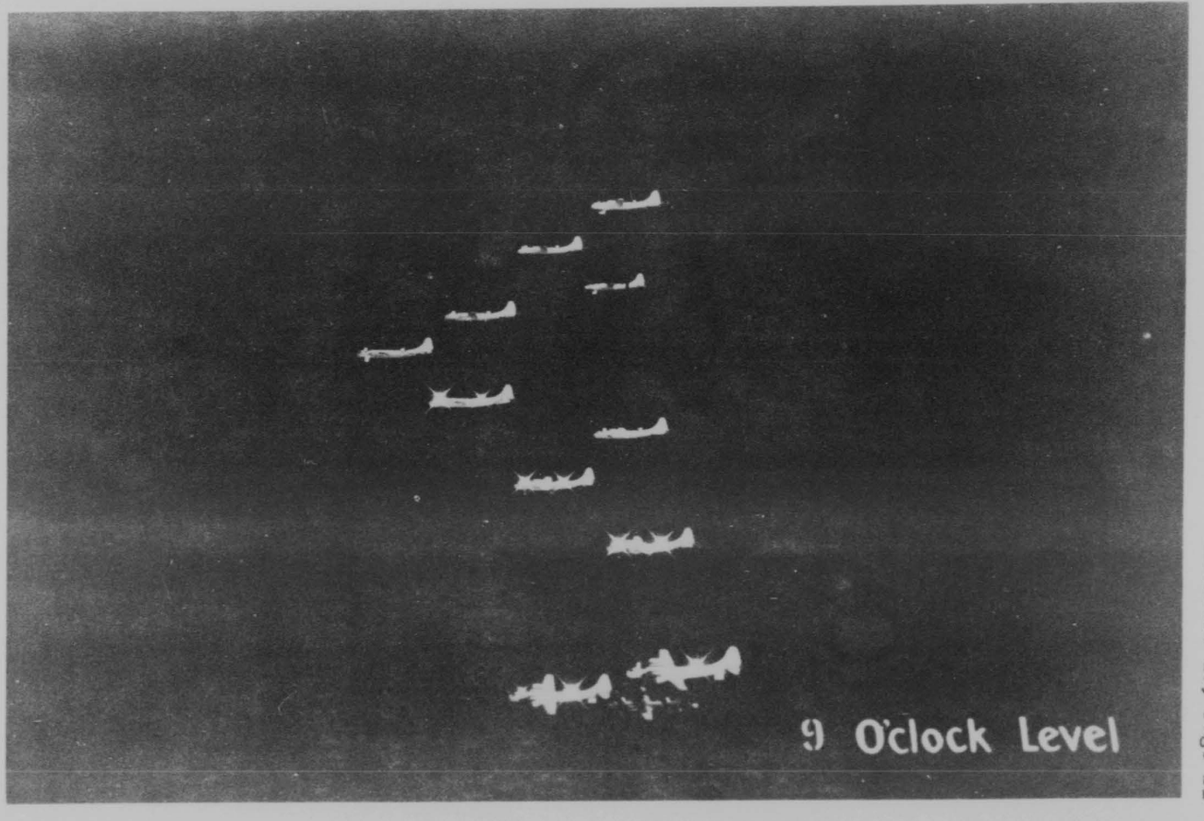








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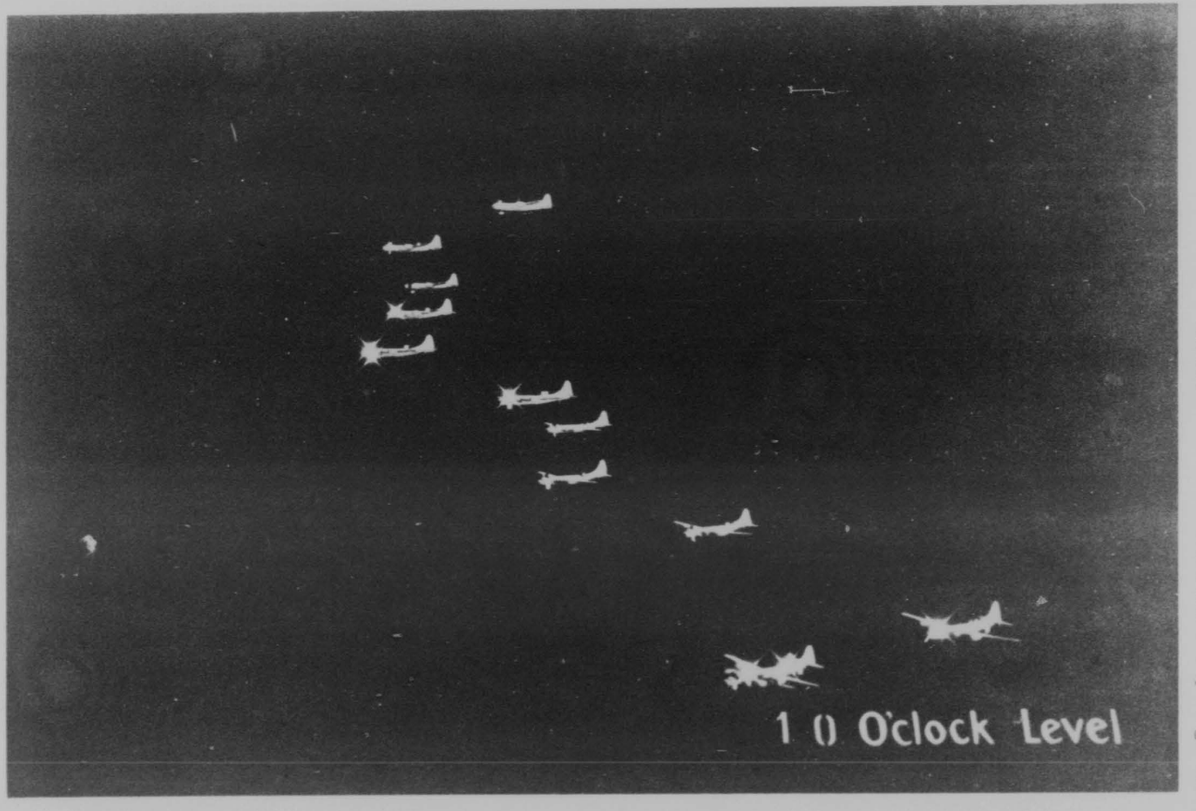








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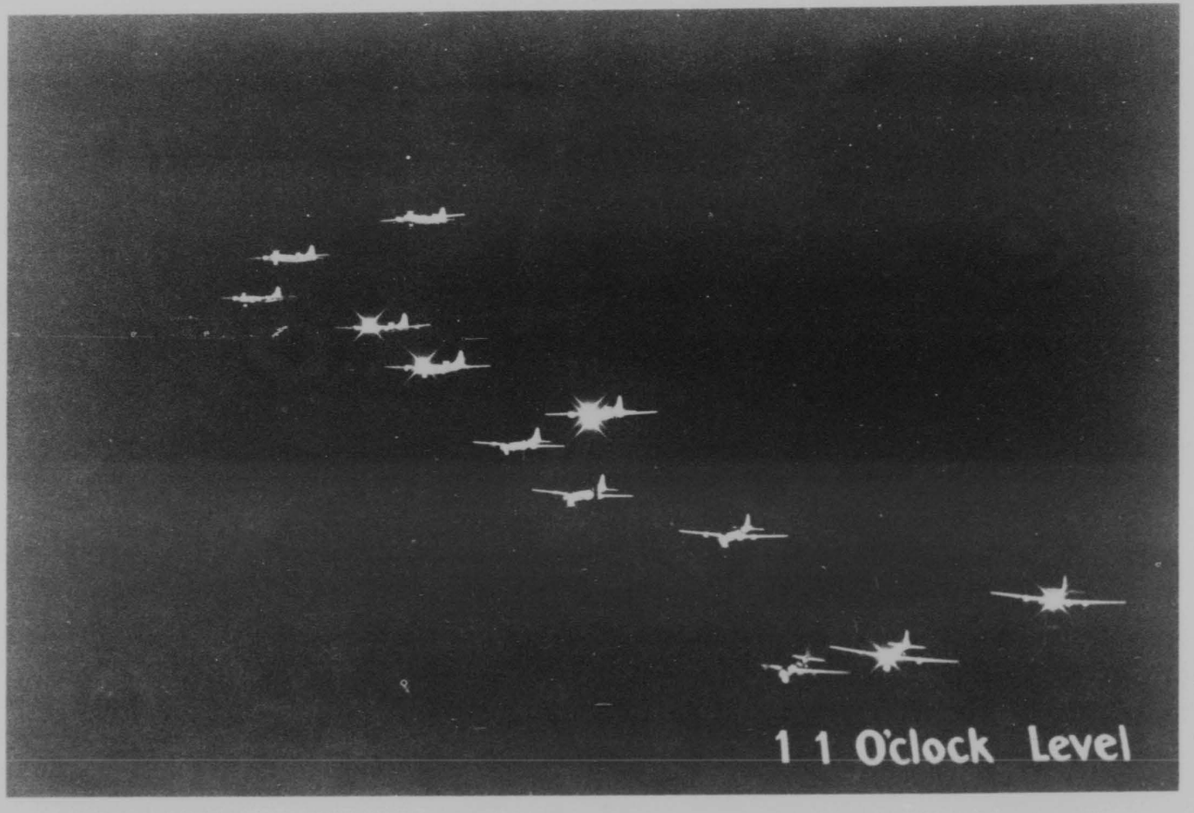


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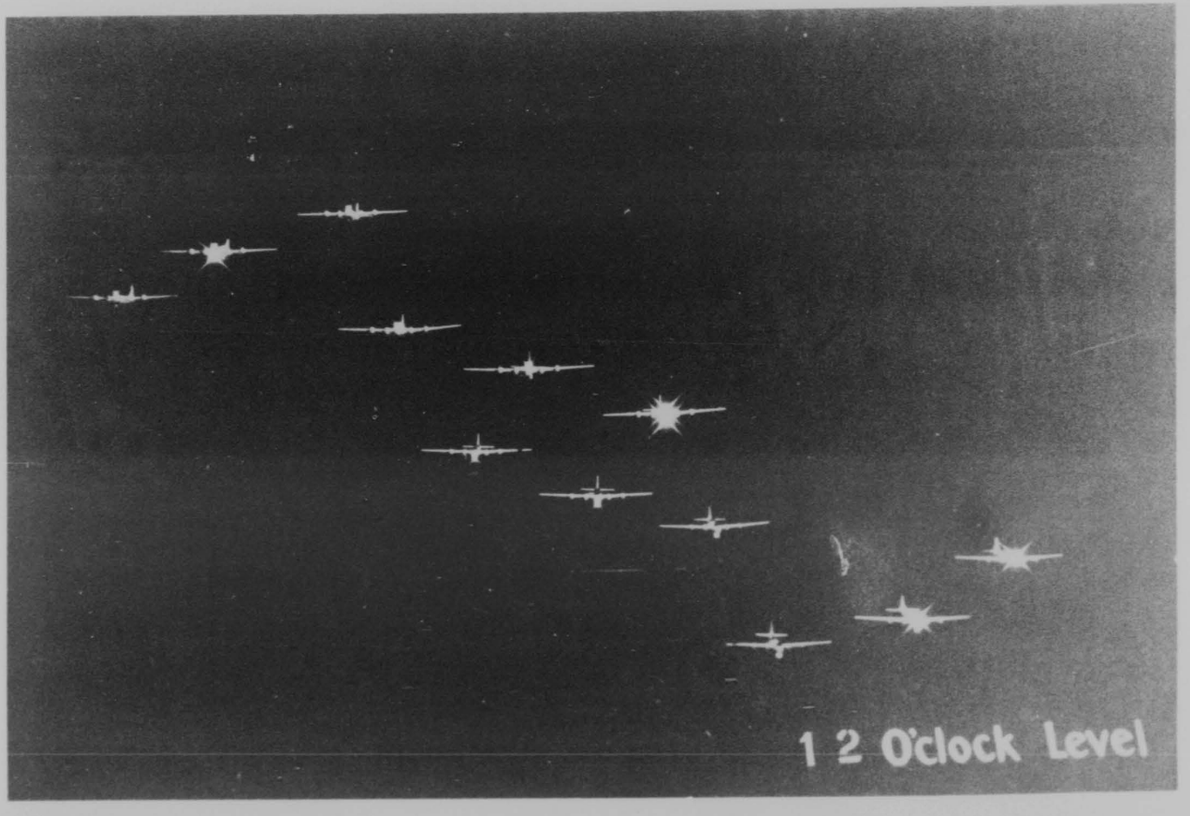








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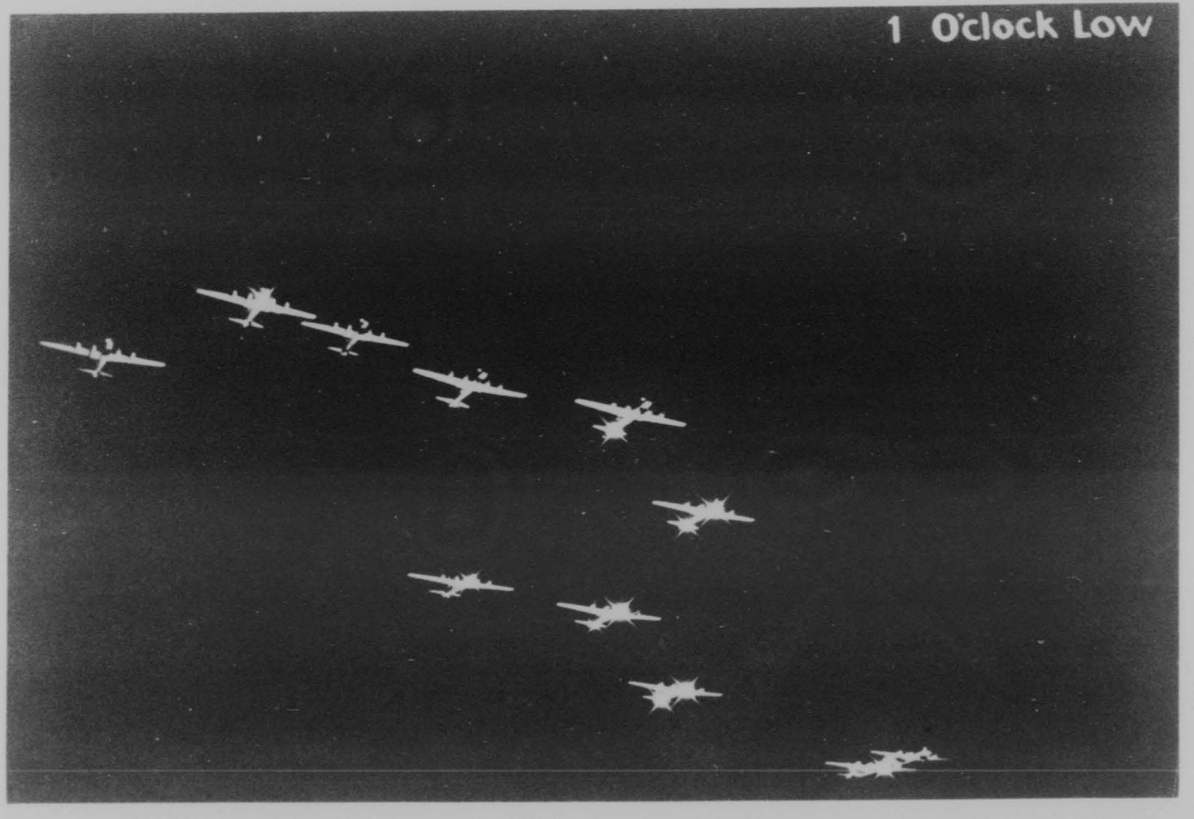


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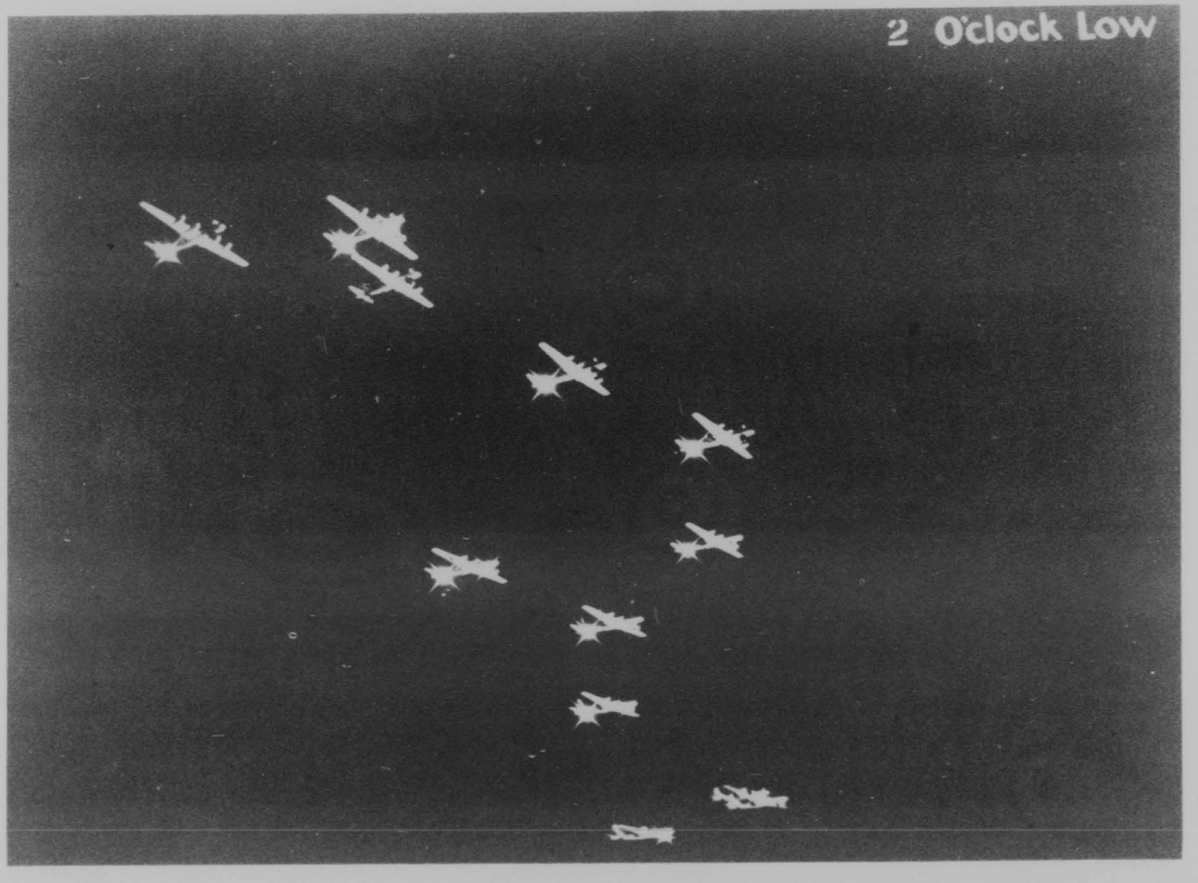


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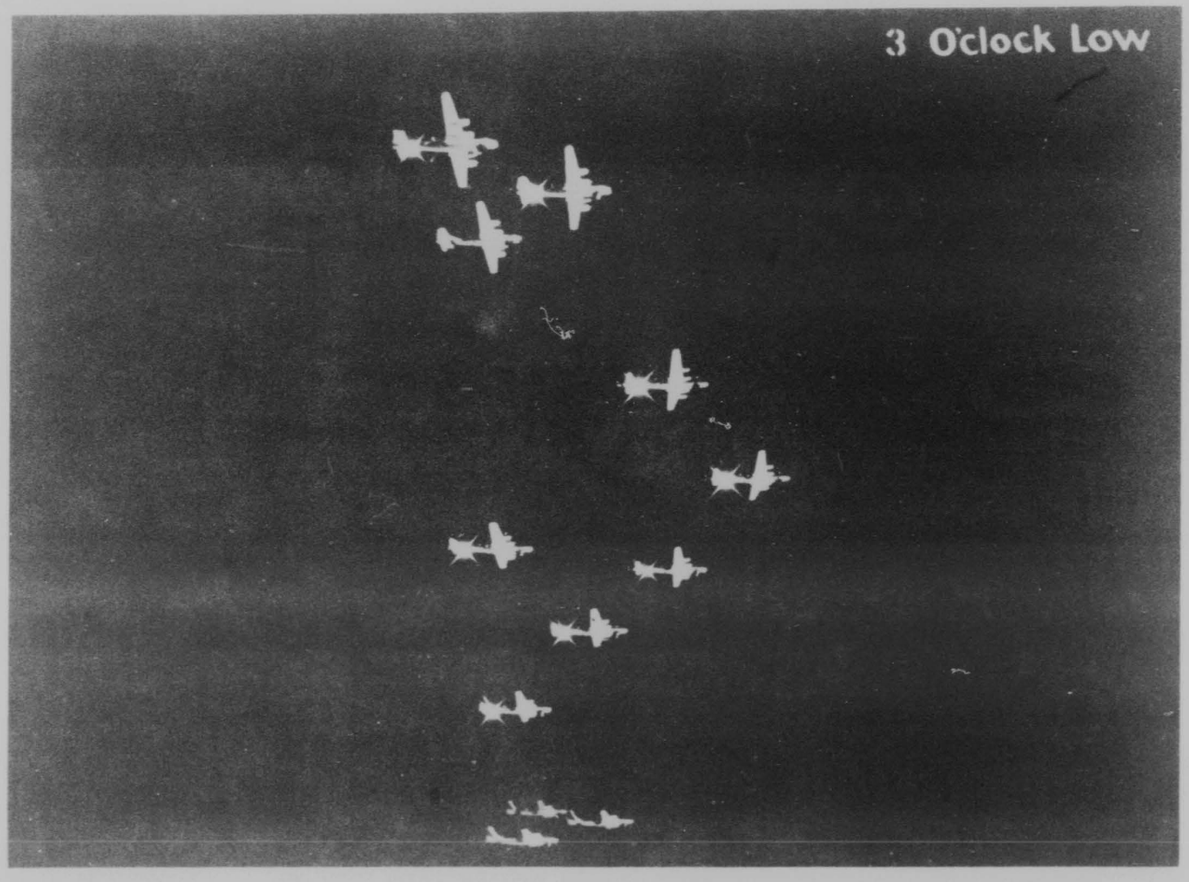


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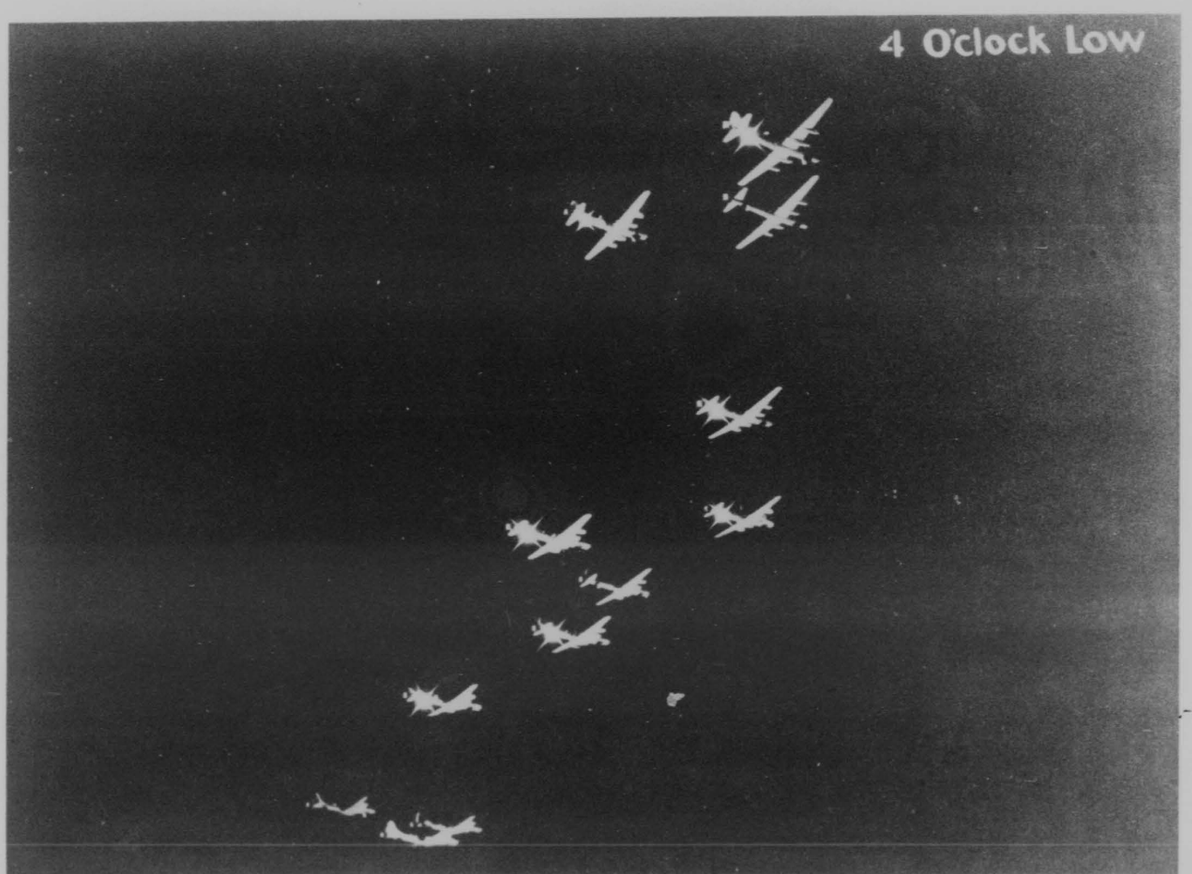


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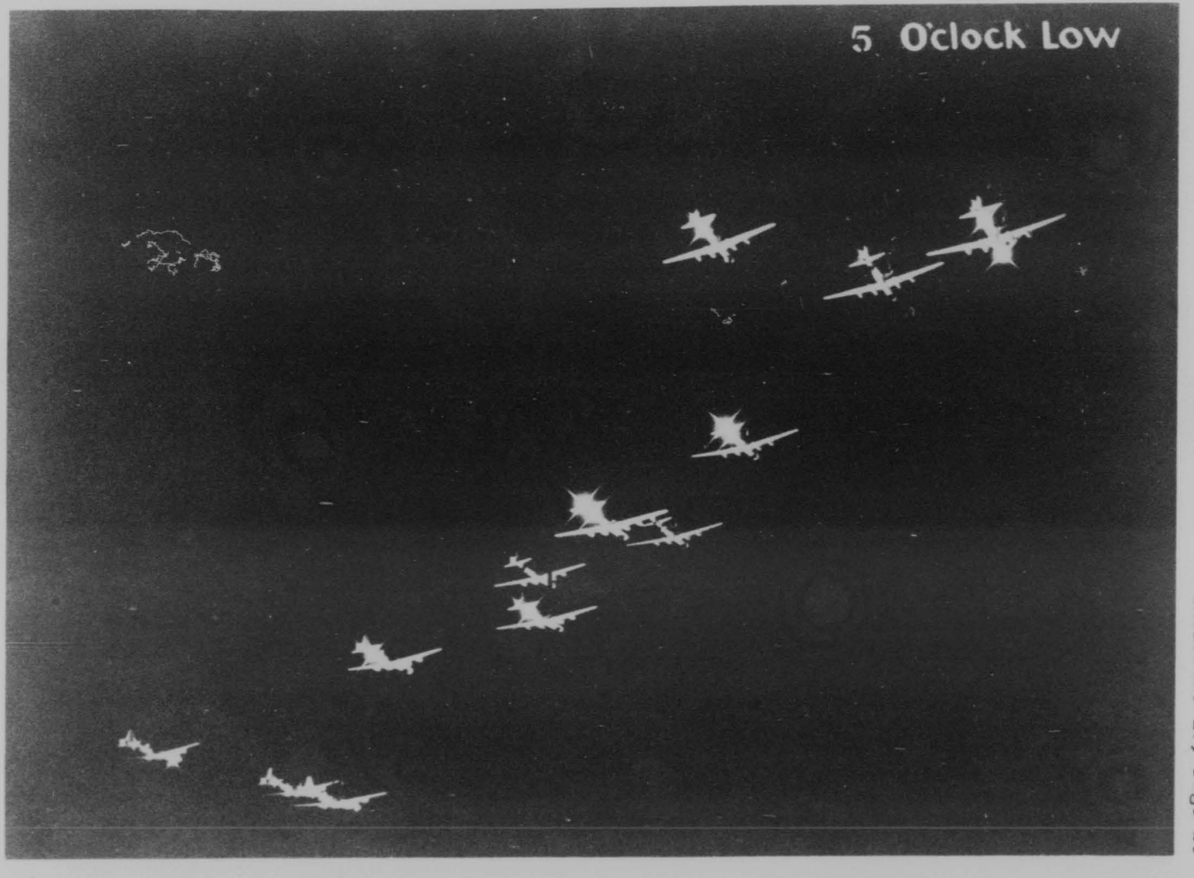


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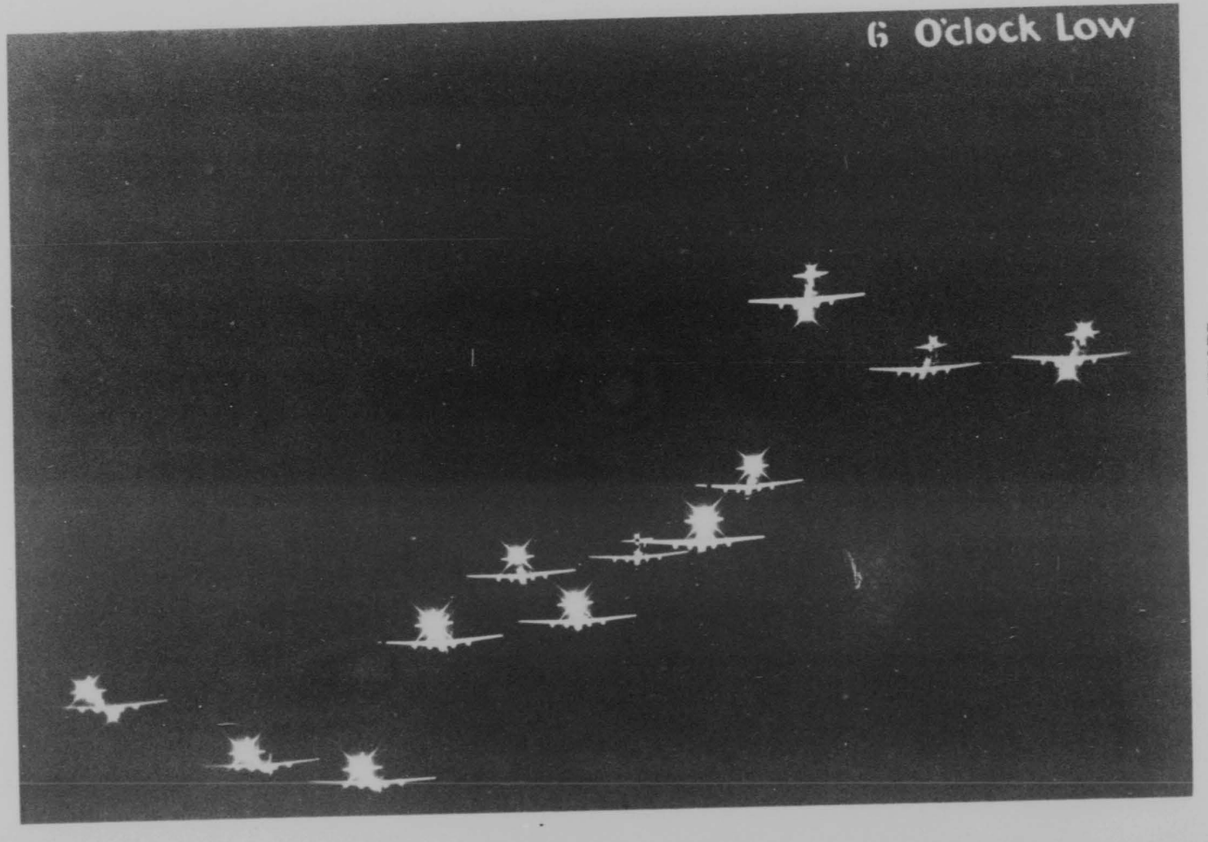


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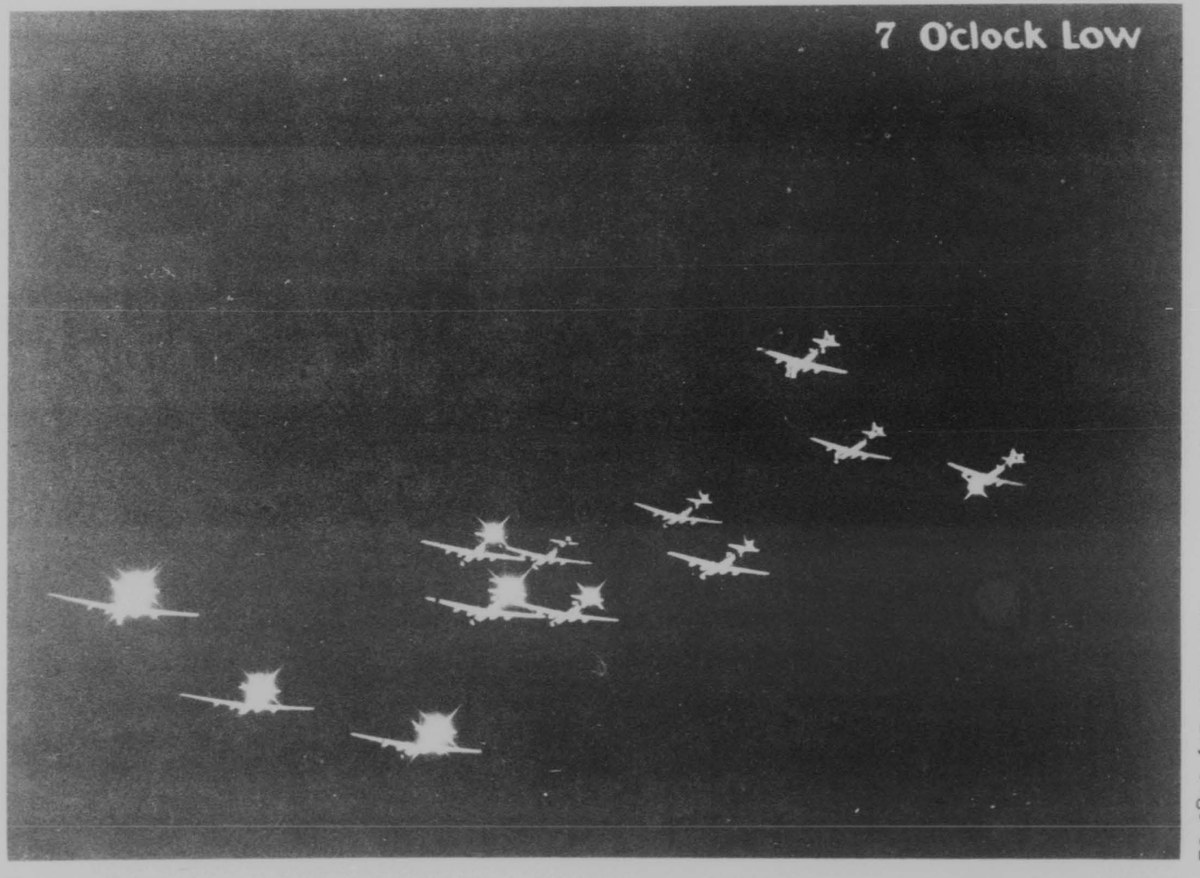


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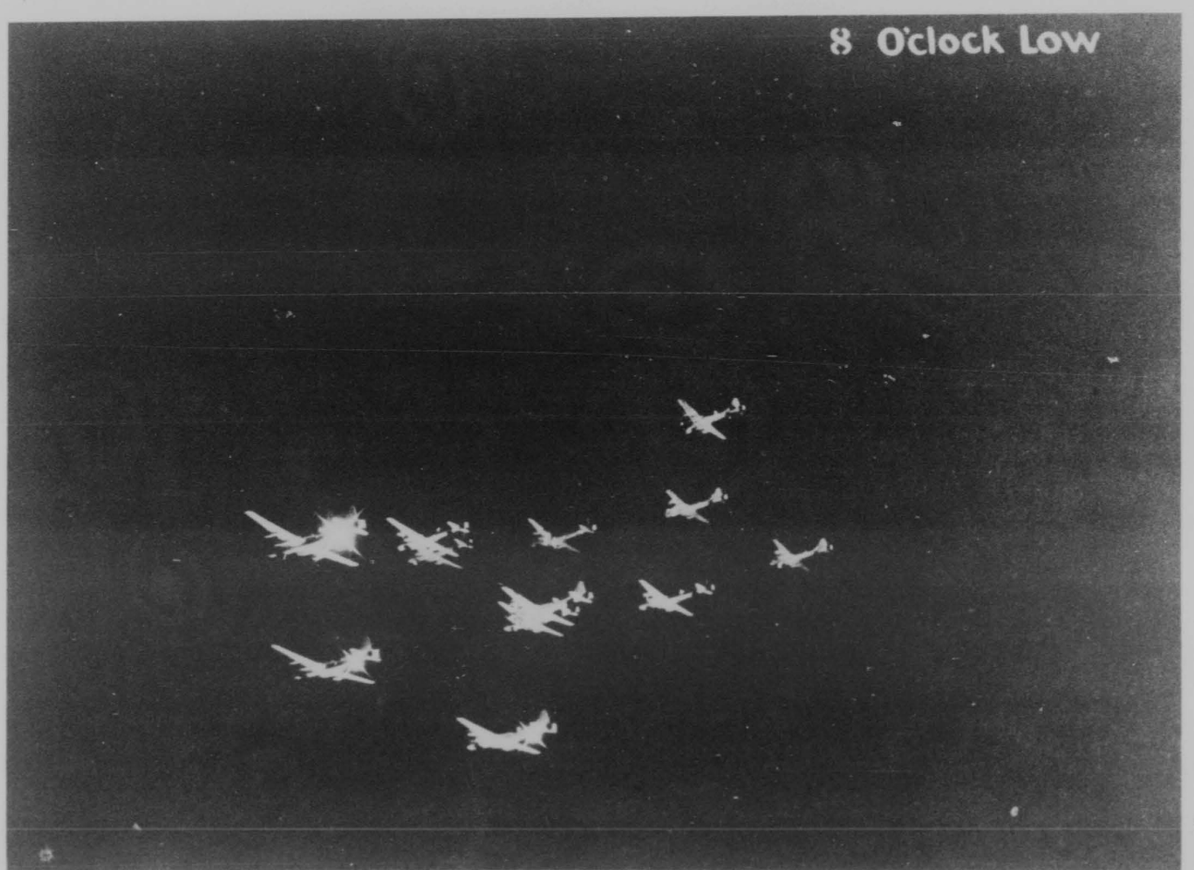


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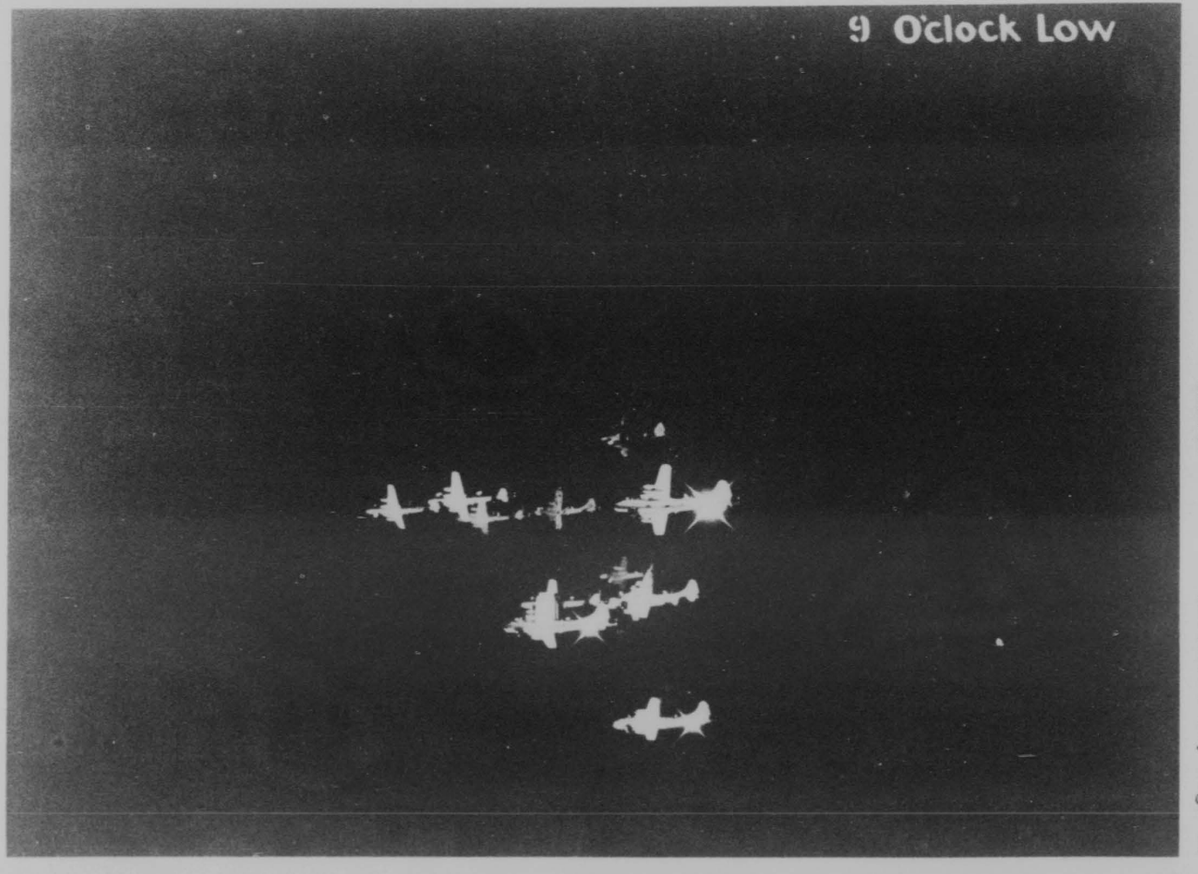


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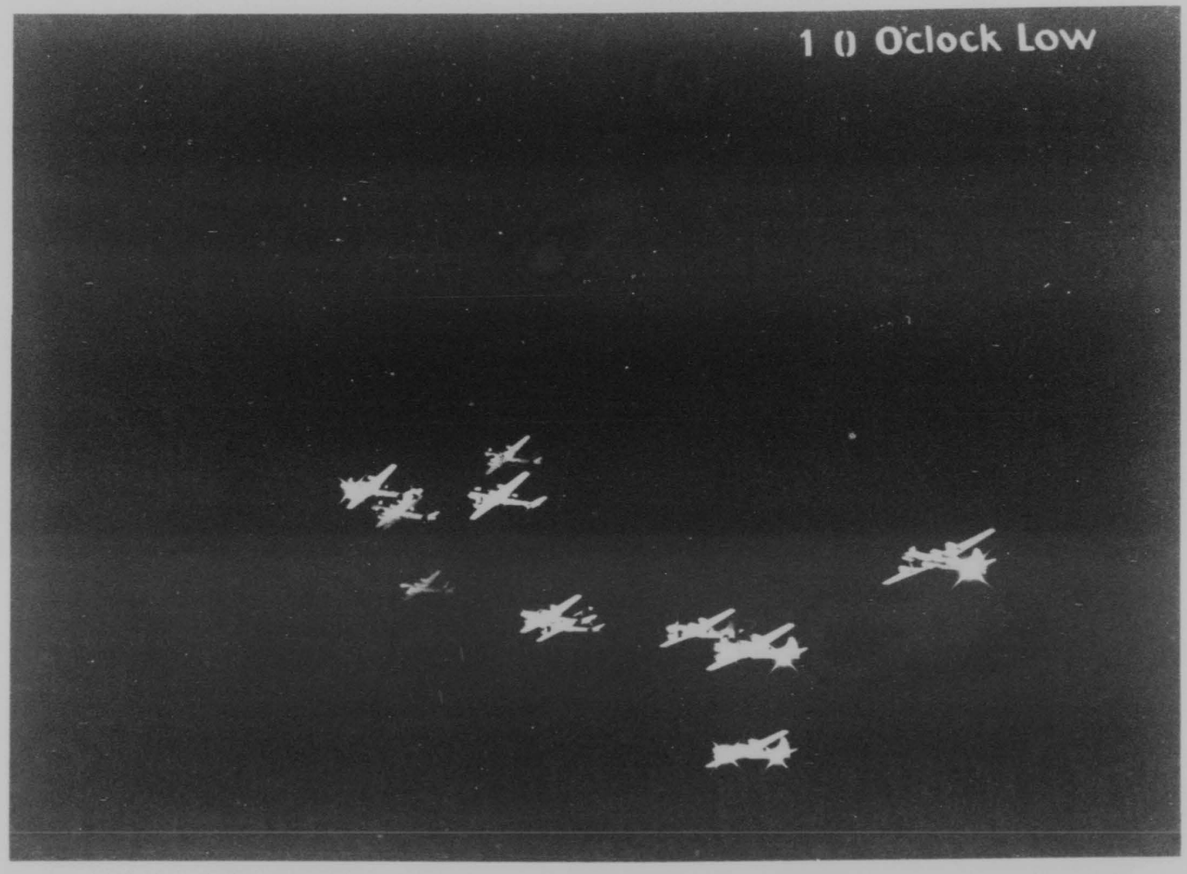


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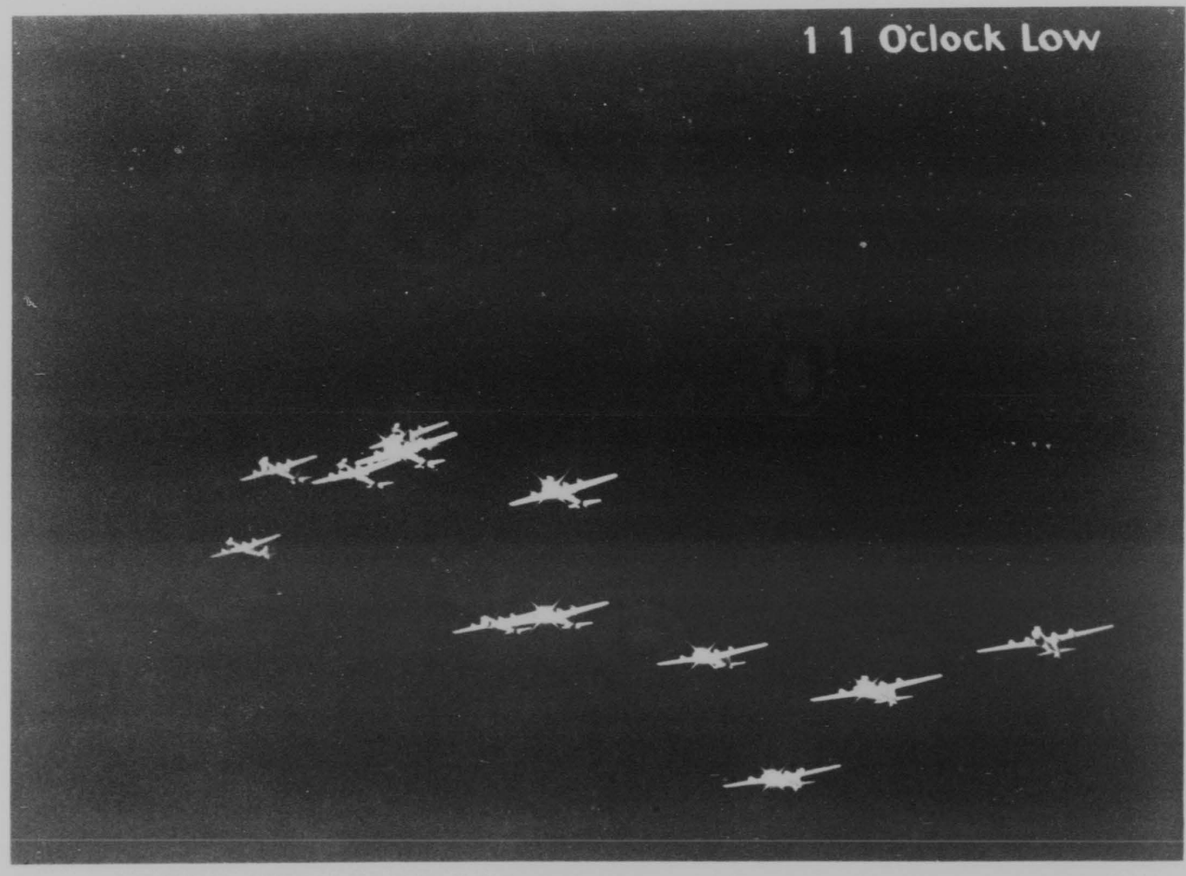


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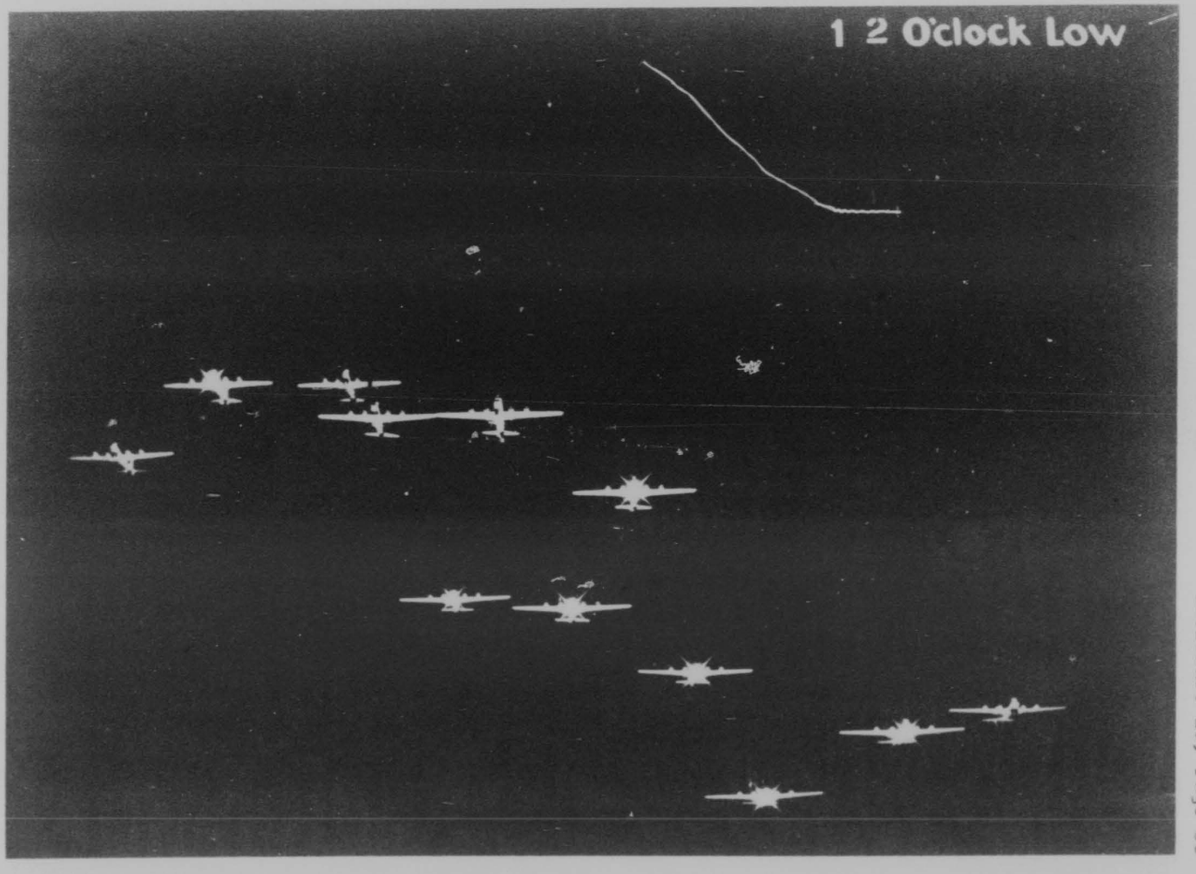


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INCLOSURE 20
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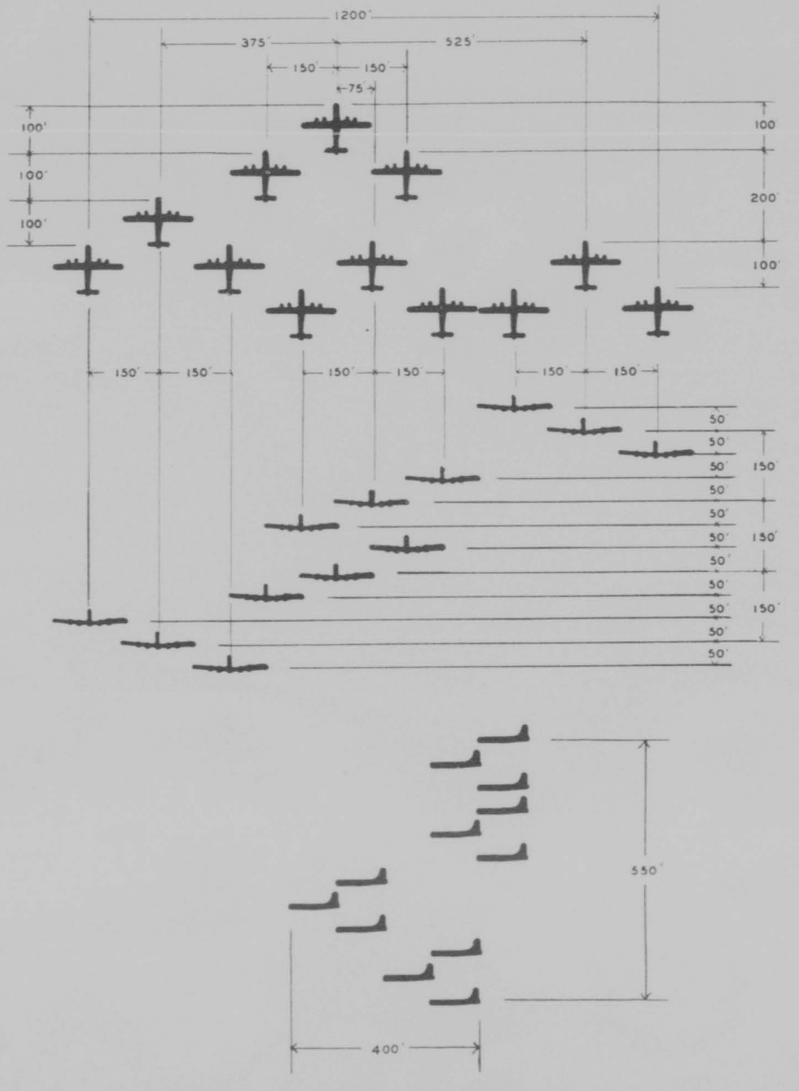
PROPOSED RESTACKED 12-PLANE B-29 FORMATION

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# PHOTOGRAPHS OF TEST FLIGHT

## Restacked 12-Plane Formation

The proposed restacking of the standard 12-plane formation (Inclosure 20) was tested in flight on 4 March 1945 by the 231st Base Unit, Alamogordo, New Mexico. The flight was made at 190 IAS at 20,000 ft.

The three photographs show the formation from clock angles of 11, 6 and 8. In the first photograph plane D-2 is hidden by the elevator of the camera plane.

It is suggested that these photographs be compared for dimensions with those taken from similar angles of the standard formation as set up with the models (Inclosure 19).



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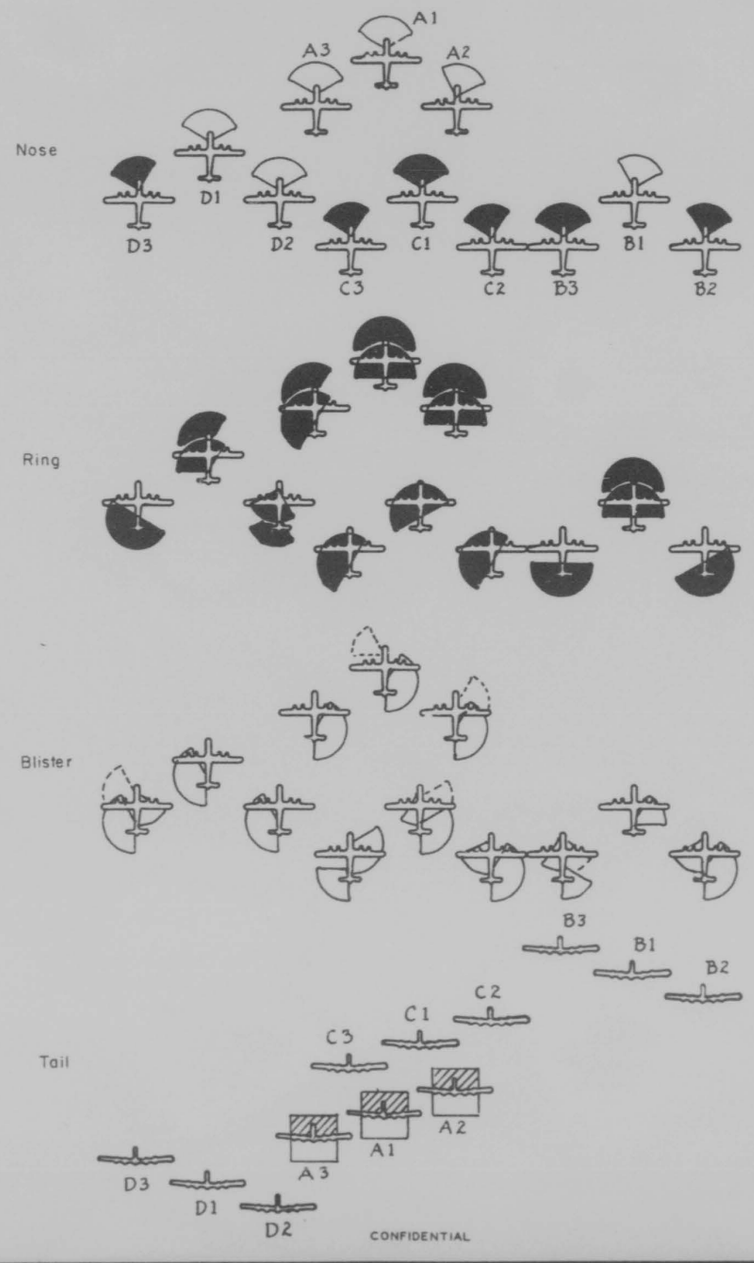
Inclosure 22

RECOMMENDED BRIEFING FOR RESTACKED 12-PLANE FORMATION

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RECOMMENDED BRIEFING FOR RESTACKED 12-PLANE FORMATION

| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | Center | HI MAN R F | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R F | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R F | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 Lo |
| B1 | Center | HI MAN R F | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Tail Hi | ONE EACH L | 10-1 | -- | -- | 7-1 | 2-6 | -- | -- | 6-9 | 5-7 |
| D1 | Center | HI MAN L F | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L A | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |



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NUMBER OF GUNS BEARING AT VARIOUS POINTS OF THE SKY

RESTACKED 12-PLANE FORMATION

| Clock Angle | High | Level | Low |
|---|---|---|---|
| 10 | 32 | 26 | 10 |
| 11 | 37 | 31 | 13 |
| 12 | 30 | 29 | 12 |
| 1 | 29 | 30 | 18 |
| 2 | 17 | 24 | 20 |
| 3 | 9 | 21 | 15 |
| 4 | 5 | 16 | 16 |
| 5 | 24 | 37 | 36 |
| 6 | 39 | 48 | 53 |
| 7 | 30 | 35 | 32 |
| 8 | 14 | 16 | 10 |
| 9 | 18 | 20 | 7 |





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LOSS OF NORMAL FIRE SUPPORT INVOLVED IN INCREASING LENGTH OF A 12-PLANE FORMATION

Due to dispersion along, support fire loses effectiveness as the square of the range increases. The table shows how straggling reduces the support fire which wing ships of elements B, C, and D can bring to bear on a fighter attacking the lead ship from various ranges.

The diagram on the following page illustrates the typical case of the fighter 600 yds. from the lead ship. Note the large difference in firepower which results from an apparently small difference in range.

| Range of Fighter from Lead Ship | Length of Formation | Range from Center of Rear Rank | Relative Strength of Support Fire | Percentage of Support Fire Lost |
|---|---|---|---|---|
| 900 yd. | Normal | 1000 | $(1000/1000)^2=1.00$ | 0 |
| | Double | 1100 | $(1000/1100)^2=0.83$ | 17. |
| | Triple | 1200 | $(1000/1200)^2=0.70$ | 30. |
| 600 yd. | Normal | 700 | $(700/700)^2=1.00$ | 0 |
| | Double | 800 | $(700/800)^2=0.77$ | 23. |
| | Triple | 900 | $(700/900)^2=0.60$ | 40. |
| 300 yd. | Normal | 400 | $(400/400)^2=1.00$ | 0 |
| | Double | 500 | $(400/500)^2=0.64$ | 36. |
| | Triple | 600 | $(400/600)^2=0.44$ | 56. |





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EFFECT ON FORWARD FIRE SUPPORT INVOLVED IN INCREASING LENGTH OF A FORMATION

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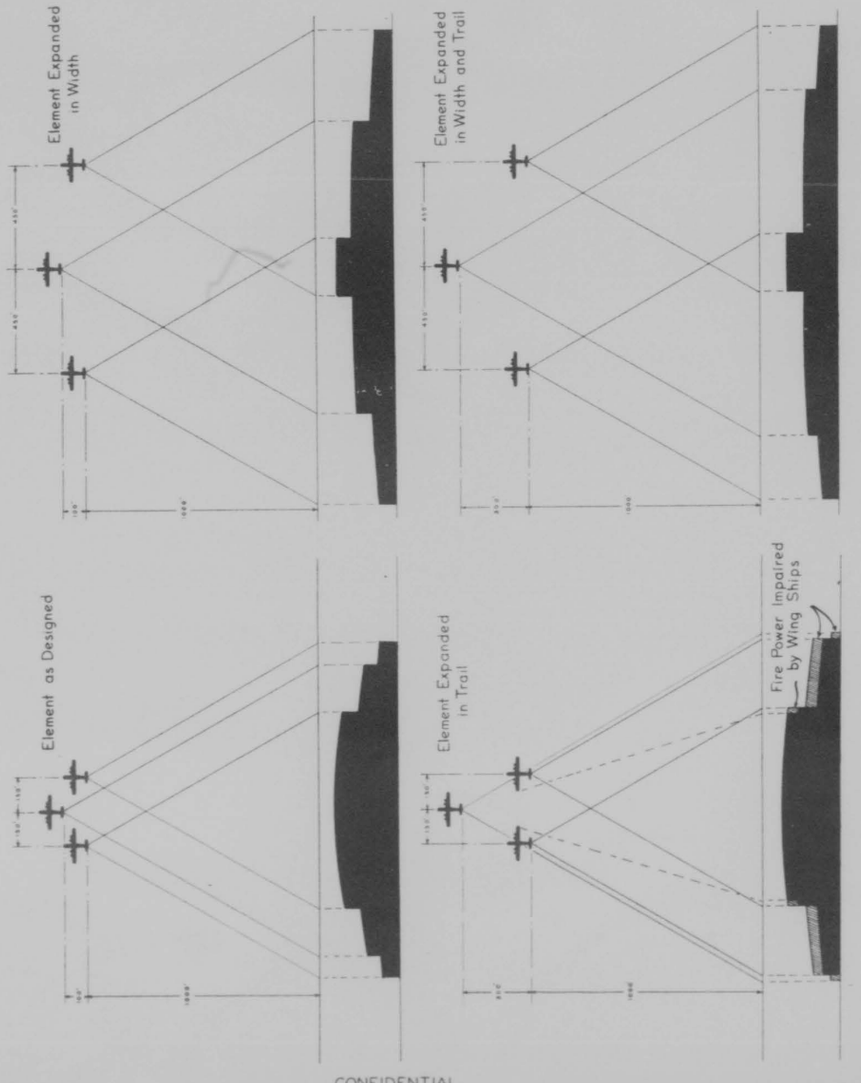
EFFECT ON SUPPORT FROM TAIL GUNS
INVOLVED IN INCREASING LENGTH AND BREADTH OF FORMATIONS

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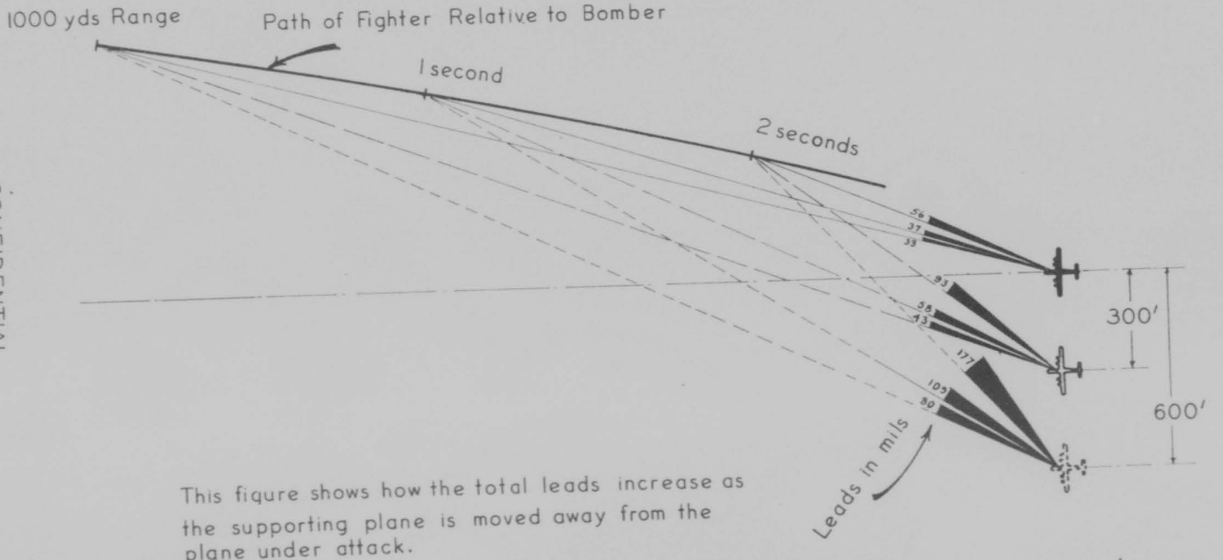
LOSS OF FORWARD FIRE SUPPORT INVOLVED IN INCREASING BREADTH OF A 12-PLANE FORMATION

Accuracy of fire depends largely on the total leads which the C.F.C. system has to compute.




This figure shows how the total leads increase as the supporting plane is moved away from the plane under attack.

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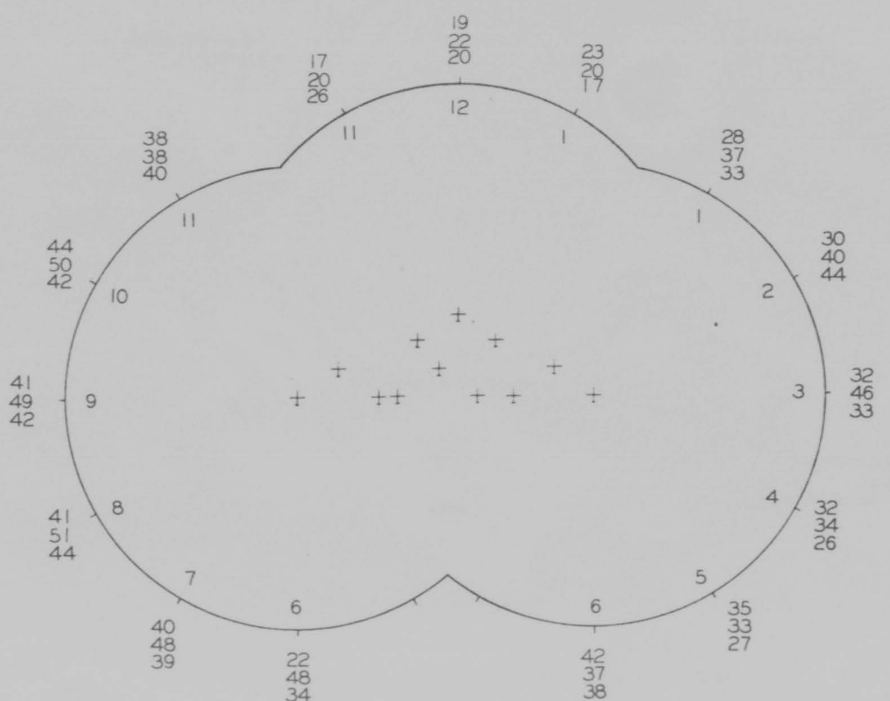
PERCENTAGE LOSS OF FIRE POWER INTENSITY

OF STANDARD B-29 FORMATION AT 600 YARDS RANGE

WHEN ALL DIMENSIONS ARE DOUBLED




Shown for Various Clock Angles

High Level Low

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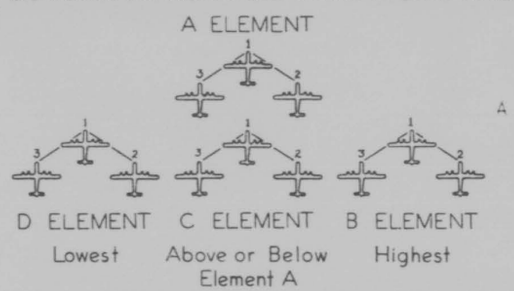
## ALLOCATION OF TURRETS AND BRIEFED AREAS OF SEARCH AND FIRE

### Formations of 1 to 12 B-29's

Diagrams and tables on the following pages give the results of applying the Rules for Turret Allocation proposed in Section III C to a representative group of formations of from 1 to 12 B-29's. All the formations illustrated are derived from a basic 12-plane formation of this form:




Formations are designated by giving the number of planes, followed by letters indicating the elements present (except that A element is omitted). Each letter is preceded by the number of planes in the element if less than three are present. The letter C is followed by "High" or "Low" to designate the stacking of C element with respect to A.

The formations listed are the following:


| | | | | | |
|---|---|---|---|---|---|
| Page 2 | 1. | 1-Plane | Page 5 | 19. | 7-Plane 2B 2D |
| | 2. | 2-Plane | | 20. | 8-Plane 2B D |
| | 3. | 3-Plane | Page 6 | 21. | 8-Plane B 2D |
| | 4. | 4-Plane 1B | | 22. | 8-Plane C Hi 1B 1D |
| | 5. | 4-Plane 1D | | 23. | 8-Plane C Low 1B 1D |
| | 6. | 4-Plane 1C Hi | | 24. | 9-Plane B D |
| | 7. | 4-Plane 1C Low | Page 7 | 25. | 10-Plane C Hi 2B 2D |
| Page 3 | 8. | 5-Plane 2C Hi | | 26. | 10-Plane C Low 2B 2D |
| | 9. | 5-Plane 2C Low | | 27. | 10-Plane 1C Hi B D |
| | 10. | 5-Plane 1B 1D | | 28. | 10-Plane 1C Low B D |
| | 11. | 5-Plane 2B | Page 8 | 29. | 11-Plane C Hi 2B D |
| | 12. | 5-Plane 2D | | 30. | 11-Plane C Low 2B D |
| Page 4 | 13. | 6-Plane B | | 31. | 11-Plane 2C Hi B D |
| | 14. | 6-Plane D | | 32. | 11-Plane 2C Low B D |
| | 15. | 6-Plane C Hi | Page 9 | 33. | 11-Plane C Hi B 2D |
| | 16. | 6-Plane C Low | | 34. | 11-Plane C Low B 2D |
| Page 5 | 17. | 7-Plane C Hi 1B | | 35. | 12-Plane C Hi B D |
| | 18. | 7-Plane C Low 1B | | 36. | 12-Plane C Low B D |


## GUNNERS' SEARCH AND FIRE AREAS

The four drawings for each formation, reading from top to bottom, indicate the gun assignments and briefed areas of search and fire for Nose, Ring, Blister and Tail gunners, respectively. Tail gunners for whom no restriction is shown use the entire coverage of the turret.



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Black areas denote upper turrets, light areas, lower turrets. Restricted areas for tail gunners are shaded.

Alternative assignments are shown in dotted lines as follows:

(a) GANG LOW is shown for plane C-1 when stacked high and for those planes with Wing Function for which it offers clear advantages.

(b) NOSE OUT (to be used during the bomb run) is shown for lead and deputy lead ships for the 12-plane formations only.

Examination of the diagrams or of the table which follows them will show that some exceptions have been made in applying the rules of Section III C (4) for precedence of the various Defensive Functions. It is a difficult question how far to go in sacrificing firepower in the rear high quarters in order to increase it in the nose high area. The general Rules for Turret Allocation go farther in this direction than do the detailed allocations suggested in the diagrams and table.

The situations in which defensive functions assigned in the table depart from the rules of precedence are of two types:

(a) When either two or three planes are present in B element, the inner one of these (which is the highest plane in the formation) is assigned Wing instead of Center Function, and the ring gunner is briefed aft.

(b) When C element and plane D-2 are absent but D-3 is present, plane D-1 is assigned Wing instead of Center Function.

Assignments in the table which come under these exceptions are indicated by (a)or (b).

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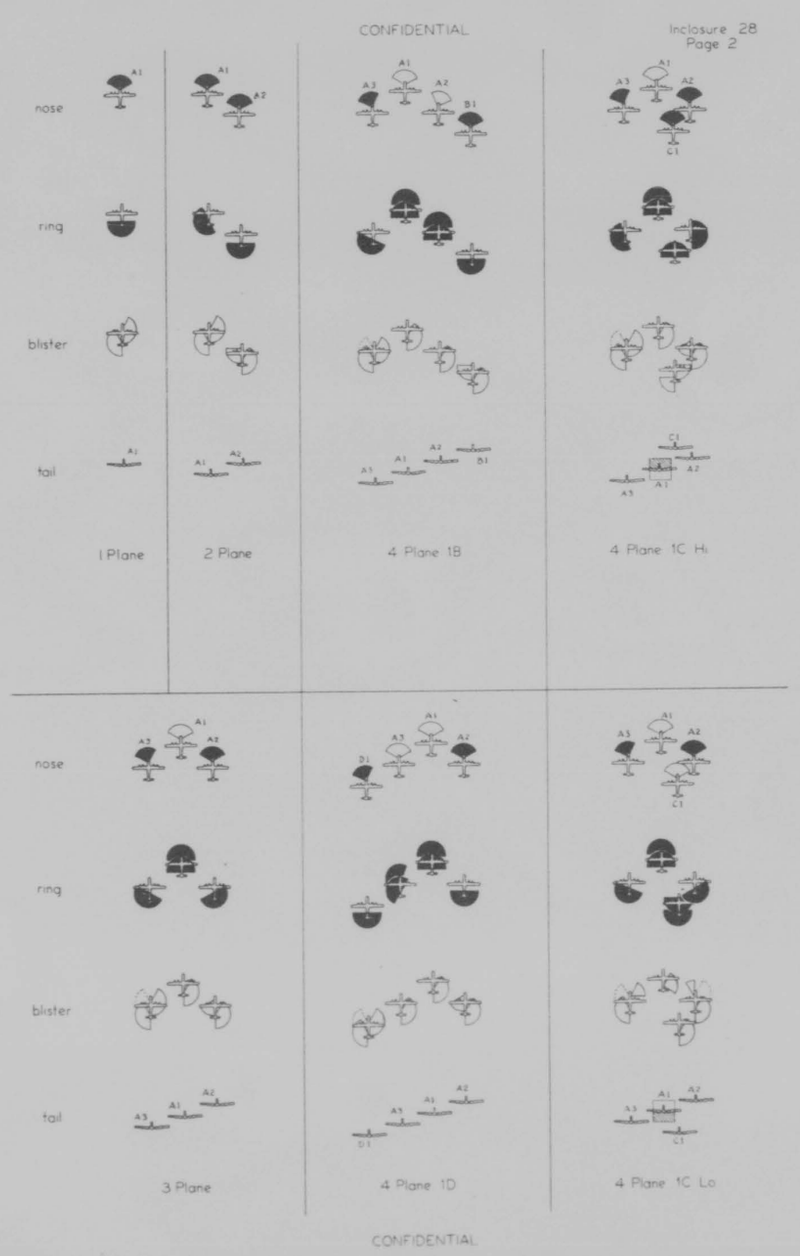


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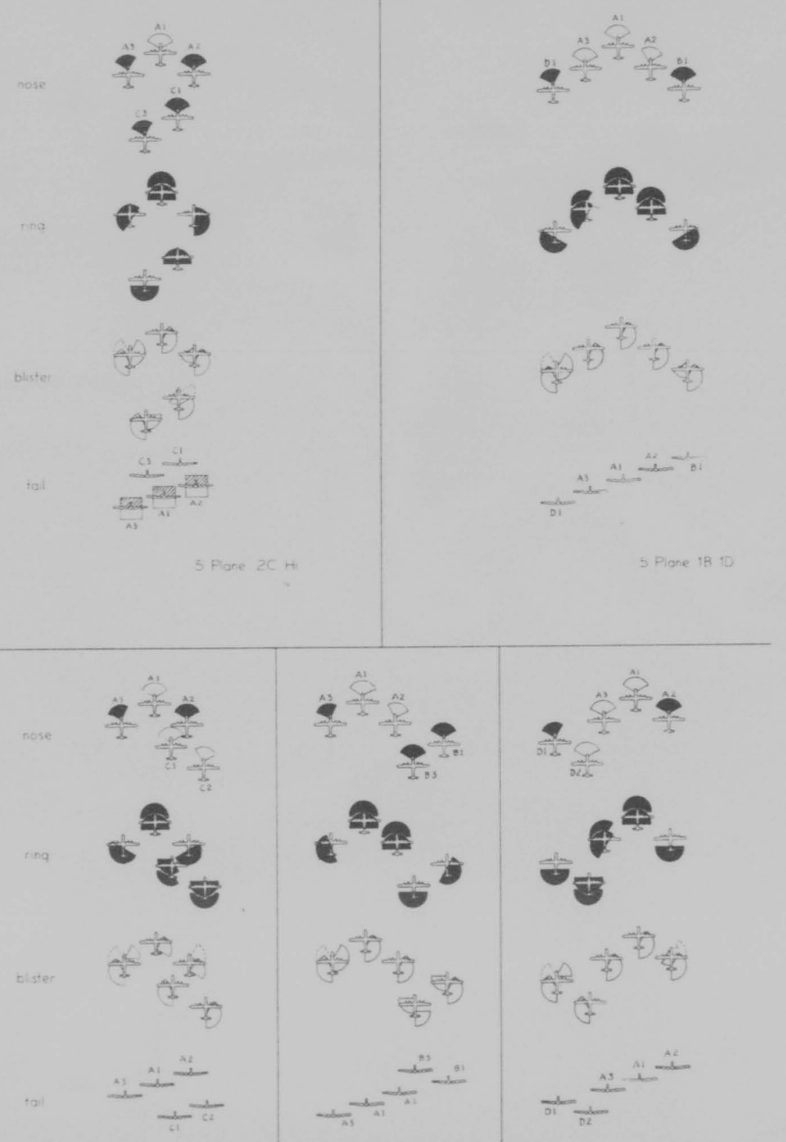




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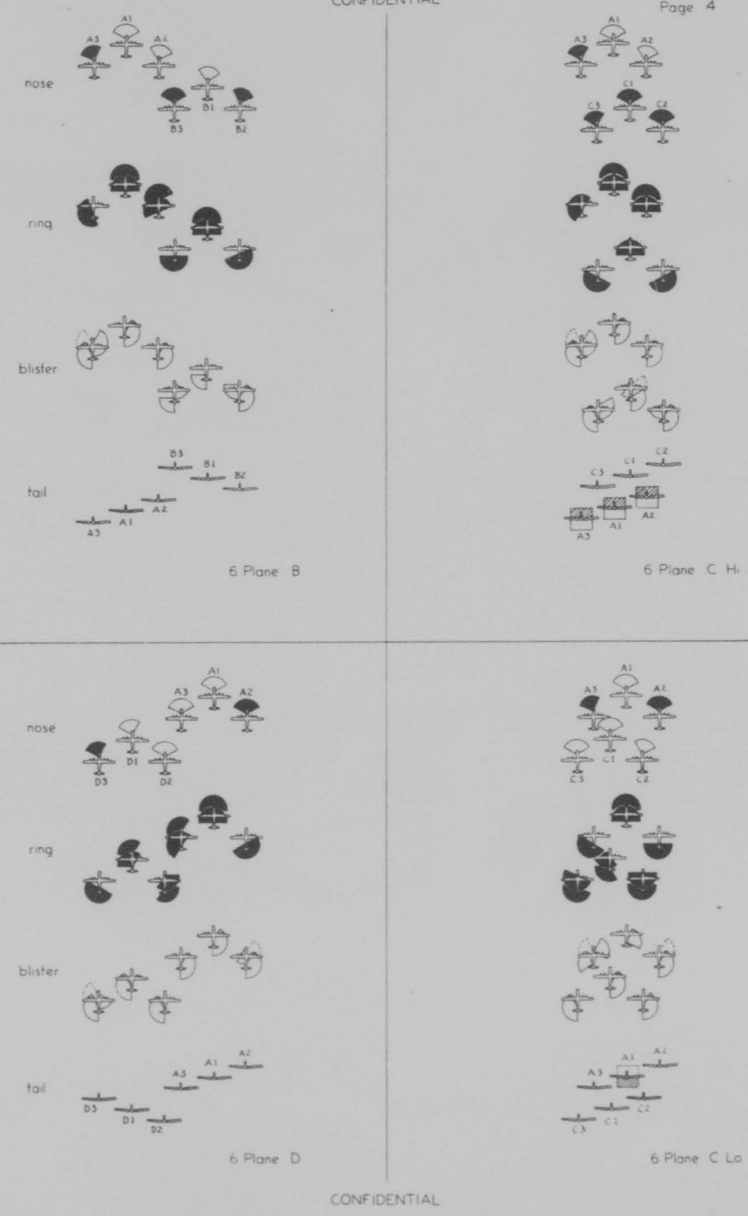




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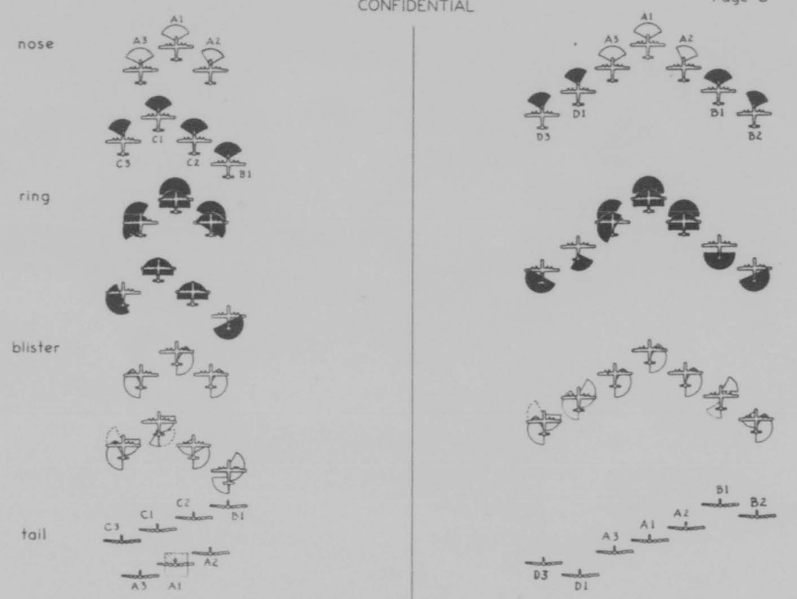
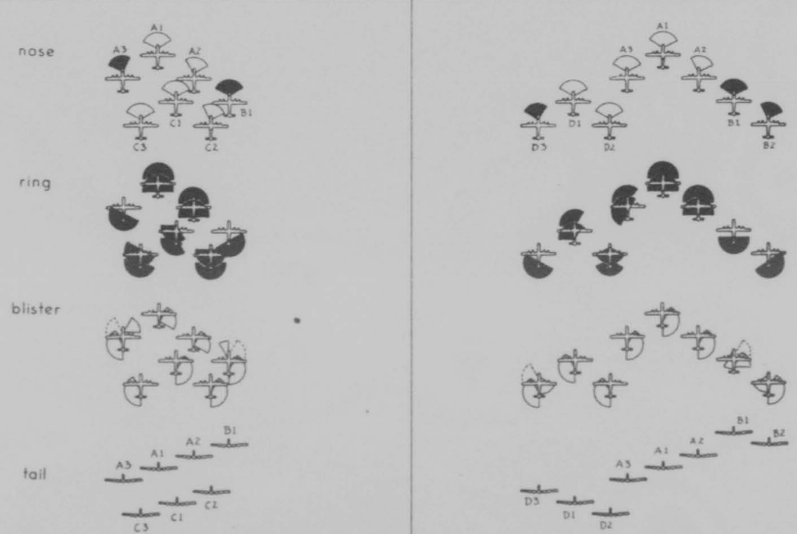



7 Plane C Hi 1B

7 Plane 2B 2D




7 Plane C Lo 1B

8 Plane 2B D

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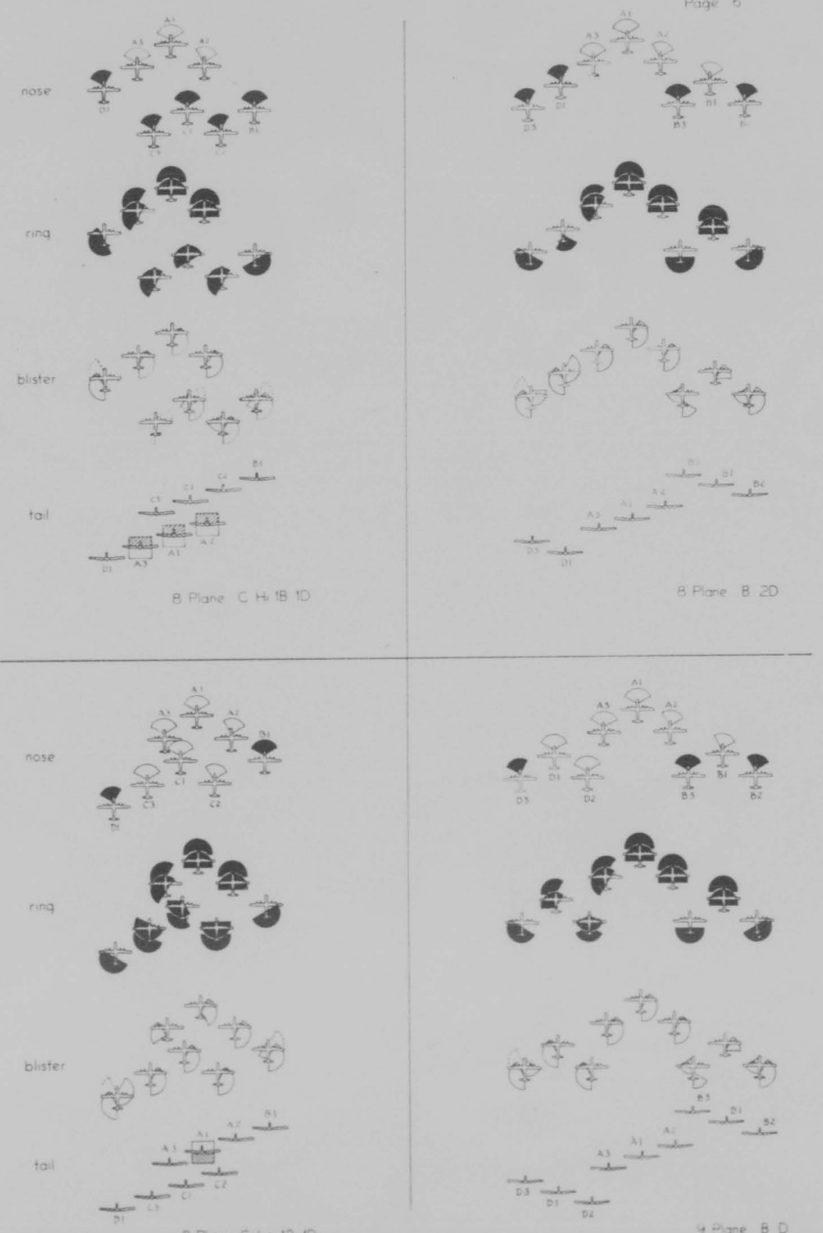


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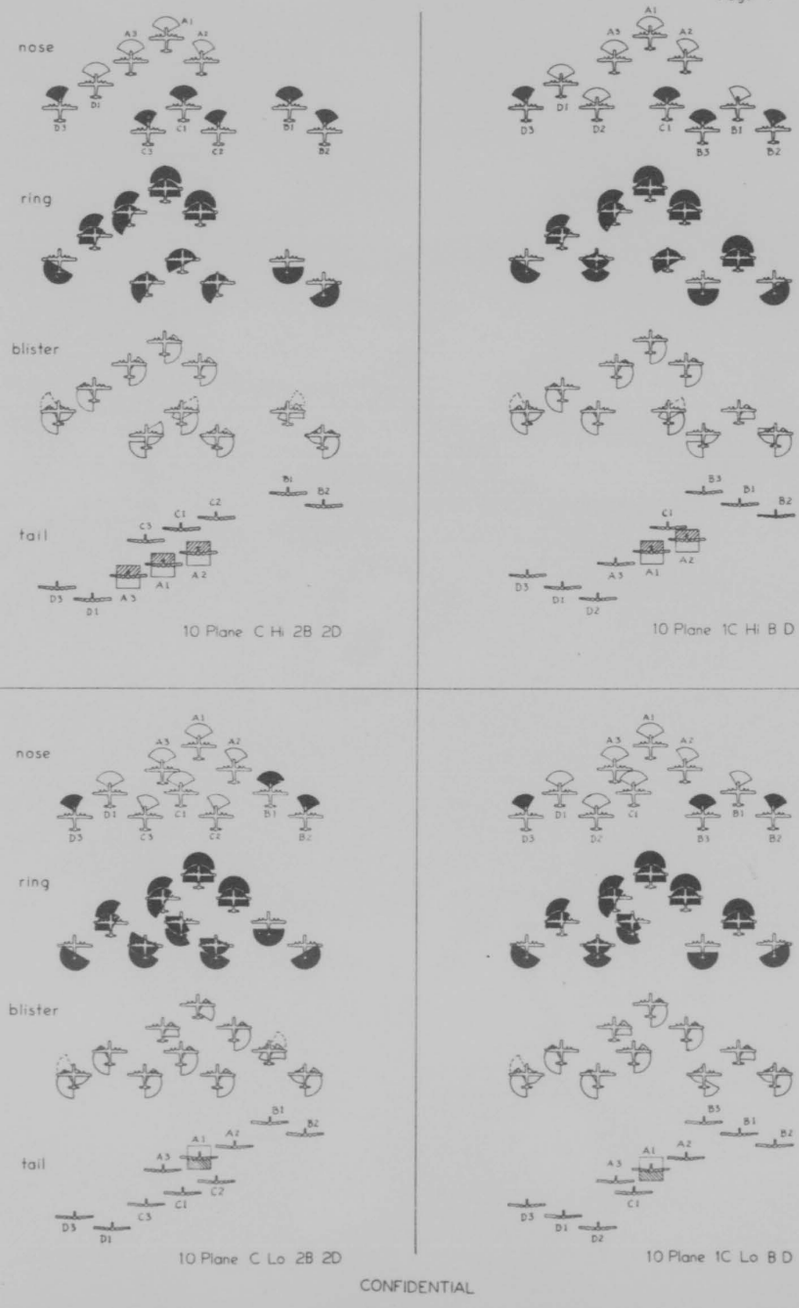




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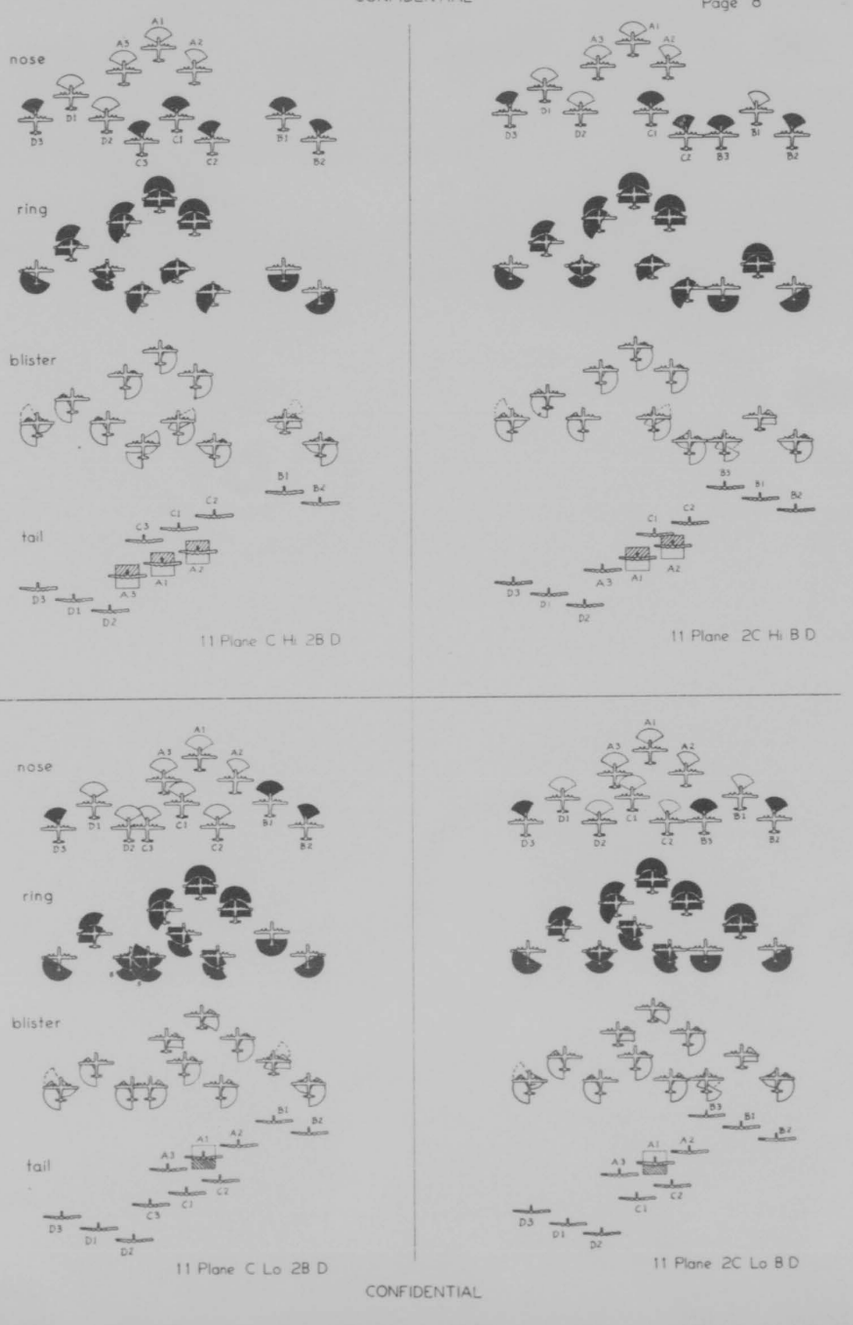




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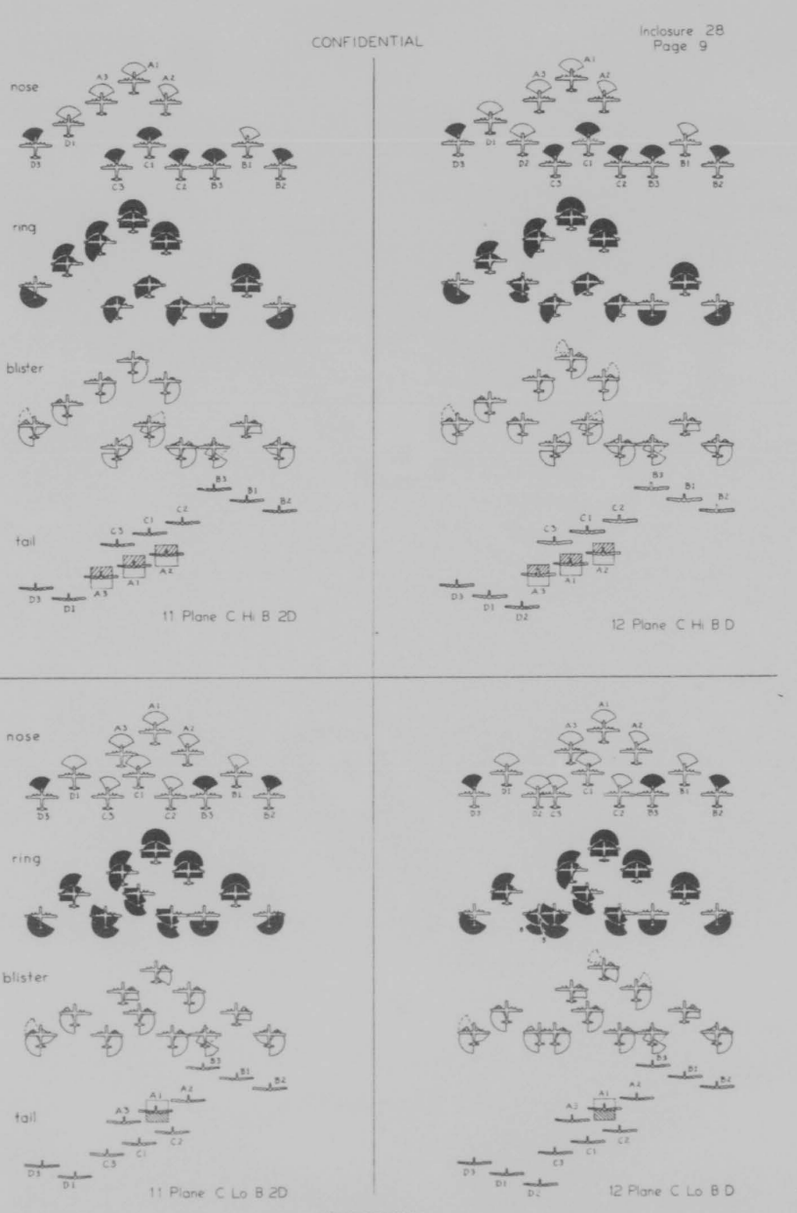




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ALLOCATION OF TURRETS AND BRIEFED AREAS OF SEARCH AND FIRE, FOR FORMATIONS OF 1-12 B-29'S

| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. 1-Plane. | | | | | | | | | | |
| A1 | Wing | ONE EACH L | 10-2 | -- | -- | 3-9 | 1-6 | -- | -- | 6-11 | 5-7 |
| | 2. 2-Plane. | | | | | | | | | | |
| A1 | Wing | ONE EACH L | 10-2 | -- | -- | 5-11 | 1-6 | -- | -- | 6-11 | 5-7 |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-6 | 6-9 | -- | 5-7 |
| | 3. 3-Plane. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-6 | -- | -- | 6-11 | 5-7 |
| | 4. 4-Plane 1B. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-6 | -- | -- | 6-11 | 5-7 |
| B1 | Wing | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-6 | 6-9 | -- | 5-7 |
| | 5. 4-Plane 1D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-6 | 6-8 | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Wing | ONE EACH L | 10-1 | -- | -- | 3-9 | 1-6 | -- | -- | 6-11 | 5-7 |
| | 6. 4-Plane 1C Hi. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 12-6 | -- | 1-6 | 6-8 | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 5-11 | 1-6 | -- | -- | 6-11 | 5-7 |
| C1 | Tail Hi | ONE EACH L | 10-2 | -- | -- | 9-3 | 3-6 | -- | -- | 6-9 | 5-7 |
| | 7. 4-Plane 1C Lo. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 11-12 | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-3 | -- | -- | 6-11 | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 3-9 | 3-9 | -- | 1-6 | -- | -- | 5-7 |
| | 8. 5-Plane 2C Hi. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 12-6 | -- | 1-6 | 6-8 | -- | 5-7 Lo |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 7-1 | 1-6 | -- | -- | 6-11 | 5-7 Lo |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 9-3 | -- | 2-6 | 6-7 | -- | 5-7 |
| C3 | Wing | ONE EACH L | 10-1 | -- | -- | 3-9 | 3-6 | -- | -- | 6-11 | 5-7 |
| | 9. 5-Plane 2C Lo. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-4 | -- | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-3 | -- | -- | 6-11 | 5-7 |
| C1 | Tail Lo | HI MAN L | -- | 10-2 | 5-9 | 5-9 | -- | -- | -- | 6-11 | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 3-9 | 3-9 | -- | 1-6 | -- | -- | 5-7 |





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| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10. 5-Plane 1B 1D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| D1 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-6 | -- | -- | 6-11 | 5-7 |
| | 11. 5-Plane 2B. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 5-11 | 1-6 | -- | -- | 6-11 | 5-7 |
| B1 | Wing | ONE EACH R | 10-2 | -- | -- | 1-7 | -- | 1-6 | 6-9 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 3-6 | 6-9 | -- | 5-7 |
| | 12. 5-Plane 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-6 | 6-7 | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Wing | ONE EACH L | 10-1 | -- | -- | 3-9 | 1-3 | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 3-9 | 3-9 | -- | -- | -- | 6-11 | 5-7 |
| | 13. 6-Plane B. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 8-2 | 8-2 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 5-11 | 1-6 | -- | -- | 6-11 | 5-7 |
| B1 | Center | HI MAN L | -- | 11-2 | 9-3 | 9-3 | -- | -- | -- | 6-9 | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-9 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH L | 10-2 | -- | -- | 3-9 | 4-6 | -- | -- | 6-9 | 5-7 |
| | 14. 6-Plane D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 6-7 | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-1 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 3-7 | 3-7 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 15. 6-Plane C Hi. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 7-1 | 1-6 | -- | -- | 6-11 | 5-7 Lo |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 9-3 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 2-6 | -- | -- | 6-11 | 5-7 |
| | 16. 6-Plane C Lo. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Wing | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-6 | 11-12 | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-4 | -- | -- | 8-11 | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 3-9 | 3-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN L | -- | 10-2 | 4-10 | 4-10 | -- | -- | -- | 6-11 | 5-7 |
| | 17. 7-Plane C Hi 1B. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 10-4 | 10-4 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN L | -- | 10-2 | 8-1 | 8-1 | -- | -- | -- | 6-11 | 5-7 Lo |
| B1 | Wing | ONE EACH L | 10-2 | -- | -- | 2-8 | 1-6 | -- | -- | 6-9 | 5-7 |
| C1 | Tail Hi | ONE EACH L | 10-2 | -- | -- | 9-3 | 3-6 | -- | -- | 6-7 | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 9-3 | -- | 2-6 | 6-8 | -- | 5-7 |
| C3 | Wing | ONE EACH L | 10-1 | -- | -- | 5-11 | 3-6 | -- | -- | 6-11 | 5-7 |





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| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L.Blister LF | L.Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18. 7-Plane C Lo 1B. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 |
| A3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 1-3 | -- | -- | 6-11 | 5-7 |
| B1 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 11-12 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 3-9 | 3-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN L | -- | 10-2 | 4-10 | 4-10 | -- | -- | -- | 6-11 | 5-7 |
| | 19. 7-Plane 2B 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Wing (a) | ONE EACH L | 10-2 | -- | -- | 3-9 | 1-3 | -- | -- | 6-8 | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| D1 | Wing (b) | ONE EACH L | 10-1 | -- | -- | 4-7 | 1-6 | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 3-6 | -- | -- | 6-11 | 5-7 |
| | 20. 8-Plane 2B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-3 | 6-7 | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 21. 8-Plane B 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-8 | -- | 5-7 |
| D1 | Wing (b) | ONE EACH L | 10-1 | -- | -- | 4-7 | 1-6 | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 3-6 | -- | -- | 6-11 | 5-7 |
| | 22. 8-Plane C Hi 1B 1D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 Lo |
| B1 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 6-7 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Tail Hi | ONE EACH L | 10-1 | -- | -- | 7-1 | 2-6 | -- | -- | 6-9 | 5-7 |
| D1 | Wing | ONE EACH L | 10-1 | -- | -- | 5-11 | 1-6 | -- | -- | 6-11 | 5-7 |
| | 23. 8-Plane C Lo 1B 1D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-5 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN L | -- | 10-2 | 7-1 | 7-1 | -- | -- | -- | 8-11 | 5-7 |
| B1 | Wing | ONE EACH R | 10-2 | -- | -- | 2-8 | -- | 1-6 | 6-7 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 3-9 | 3-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN R | -- | 10-2 | 4-10 | 4-10 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 2-6 | -- | -- | 6-11 | 5-7 |



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| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 24. 9-Plane B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-8 | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 25. 10-Plane C Hi 2B 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 Lo |
| B1 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-3 | 6-7 | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Tail Hi | ONE EACH L | 10-1 | -- | -- | 7-1 | 2-6 | -- | -- | 6-9 | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 26. 10-Plane C Lo 2B 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-3 | 6-7 | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 4-9 | 4-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN R | -- | 11-2 | 4-10 | 4-10 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 27. 10-Plane 1C Hi B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-9 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH L | 10-2 | -- | -- | 3-9 | 4-6 | -- | -- | 6-9 | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 28. 10-Plane 1C Lo B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-8 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |



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| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 29. 11-Plane C Hi 2B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | -- | 1-6 | -- | -- | -- | 5-7 |
| B1 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-3 | 6-7 | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Tail Hi | ONE EACH L | 10-1 | -- | -- | 7-1 | 2-6 | -- | -- | 6-9 | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 30. 11-Plane C Lo 2B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 1-3 | 6-7 | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN R | -- | 11-2 | 4-10 | 4-10 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 31. 11-Plane 2C Hi B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 32. 11-Plane 2C Lo B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | -7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 4-8 | 4-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |



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| Plane | Defensive Function | Turret Allocation | Nose UF | Nose LF | Ring UF | Ring UA | R. Blister LF | R. Blister LA | L. Blister LF | L. Blister LA | Tail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 33. 11-Plane C Hi B 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 Lo |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Tail Hi | ONE EACH I | 10-1 | -- | -- | 7-1 | 2-6 | -- | -- | 6-9 | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 34. 11-Plane C Lo B 2D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN R | -- | 11-2 | 4-10 | 4-10 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 35. 12-Plane C Hi B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 Lo |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-6 | -- | -- | 5-7 Lo |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Hi | ONE EACH R | 10-2 | -- | -- | 8-2 | -- | 2-6 | 6-7 | -- | 5-7 |
| C2 | Tail Hi | ONE EACH R | 10-1 | -- | -- | 7-1 | -- | 1-6 | 6-8 | -- | 5-7 |
| C3 | Tail Hi | ONE EACH L | 10-1 | -- | -- | 7-1 | 2-6 | -- | -- | 6-9 | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |
| | 36. 12-Plane C Lo B D. | | | | | | | | | | |
| A1 | Center | HI MAN R | -- | 10-2 | 9-3 | 9-3 | -- | 1-4 | -- | -- | 5-7 Hi |
| A2 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-6 | -- | -- | 5-7 |
| A3 | Center | HI MAN R | -- | 10-2 | 7-1 | 7-1 | -- | 1-3 | -- | -- | 5-7 |
| B1 | Center | HI MAN R | -- | 11-2 | 9-3 | 9-3 | -- | 1-3 | -- | -- | 5-7 |
| B2 | Wing | ONE EACH R | 11-2 | -- | -- | 2-8 | -- | 1-6 | 6-8 | -- | 5-7 |
| B3 | Wing (a) | ONE EACH R | 10-2 | -- | -- | 3-9 | -- | 4-6 | 6-7 | -- | 5-7 |
| C1 | Tail Lo | HI MAN R | -- | 10-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C2 | Tail Lo | HI MAN R | -- | 11-2 | 5-9 | 5-9 | -- | 1-6 | -- | -- | 5-7 |
| C3 | Tail Lo | HI MAN R | -- | 11-2 | 4-10 | 4-10 | -- | 1-6 | -- | -- | 5-7 |
| D1 | Center | HI MAN L | -- | 10-2 | 9-1 | 9-1 | -- | -- | -- | 6-11 | 5-7 |
| D2 | Tail Lo | HI MAN L | -- | 10-2 | 5-8 | 5-8 | -- | -- | -- | 6-11 | 5-7 |
| D3 | Wing | ONE EACH L | 10-1 | -- | -- | 4-10 | 4-6 | -- | -- | 6-11 | 5-7 |

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NUMBER OF GUNS BEARING
AT VARIOUS POINTS OF THE SKY
FORMATIONS OF 1 TO 12 B-29'S

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| | Nose | | | | | Beam | | Tail | | | Beam | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clock Angle | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1. 1-Plane. | | | | | | | | | | | | |
| High | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 4 | 4 | 4 | 2 | 1 |
| Level | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 4 | 4 | 4 | 3 | 2 |
| Low | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 4 | 5 | 4 | 2 | 2 |
| 2. 2-Plane. | | | | | | | | | | | | |
| High | 4 | 5 | 4 | 4 | 2 | 1 | 2 | 6 | 8 | 7 | 4 | 3 |
| Level | 4 | 4 | 4 | 4 | 5 | 4 | 3 | 8 | 9 | 8 | 4 | 4 |
| Low | 2 | 1 | 0 | 2 | 4 | 4 | 4 | 7 | 10 | 7 | 4 | 3 |
| 3. 3-Plane. | | | | | | | | | | | | |
| High | 7 | 8 | 7 | 7 | 6 | 4 | 3 | 8 | 11 | 8 | 3 | 4 |
| Level | 6 | 8 | 7 | 7 | 10 | 8 | 6 | 11 | 13 | 10 | 4 | 4 |
| Low | 3 | 3 | 2 | 5 | 7 | 6 | 5 | 10 | 14 | 8 | 3 | 2 |
| 4. 4-Plane 1B. | | | | | | | | | | | | |
| High | 11 | 12 | 10 | 11 | 9 | 5 | 3 | 10 | 14 | 10 | 4 | 7 |
| Level | 8 | 11 | 10 | 11 | 11 | 10 | 8 | 15 | 17 | 11 | 4 | 8 |
| Low | 3 | 4 | 4 | 8 | 10 | 8 | 8 | 14 | 18 | 10 | 4 | 3 |
| 5. 4-Plane 1D. | | | | | | | | | | | | |
| High | 10 | 12 | 10 | 9 | 5 | 4 | 4 | 10 | 14 | 12 | 7 | 8 |
| Level | 9 | 12 | 10 | 10 | 9 | 10 | 8 | 15 | 17 | 12 | 5 | 8 |
| Low | 4 | 5 | 4 | 8 | 10 | 8 | 8 | 14 | 18 | 10 | 3 | 2 |
| 6. 4-Plane 1C Hi. | | | | | | | | | | | | |
| High | 11 | 13 | 10 | 13 | 10 | 5 | 2 | 8 | 10 | 6 | 2 | 5 |
| Level | 9 | 10 | 9 | 9 | 10 | 9 | 5 | 13 | 16 | 11 | 5 | 6 |
| Low | 3 | 3 | 2 | 5 | 7 | 7 | 8 | 14 | 19 | 12 | 5 | 3 |





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| | Nose | | | | | Beam | | Tail | | | Beam | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clock Angle | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **7. 4-Plane 1C Low.** | | | | | | | | | | | | |
| High | 7 | 8 | 7 | 7 | 6 | 6 | 6 | 14 | 17 | 14 | 6 | 6 |
| Level | 8 | 10 | 9 | 9 | 10 | 11 | 8 | 13 | 14 | 11 | 4 | 6 |
| Low | 4 | 5 | 5 | 9 | 10 | 7 | 5 | 8 | 12 | 6 | 2 | 2 |
| **8. 5-Plane 2C Hi.** | | | | | | | | | | | | |
| High | 12 | 16 | 14 | 15 | 10 | 7 | 4 | 7 | 8 | 6 | 4 | 6 |
| Level | 11 | 12 | 11 | 10 | 10 | 12 | 8 | 15 | 18 | 12 | 6 | 8 |
| Low | 5 | 4 | 2 | 5 | 8 | 9 | 10 | 18 | 24 | 14 | 5 | 4 |
| **9. 5-Plane 2C Low.** | | | | | | | | | | | | |
| High | 7 | 8 | 7 | 7 | 6 | 7 | 8 | 20 | 24 | 22 | 11 | 9 |
| Level | 8 | 11 | 11 | 11 | 10 | 12 | 8 | 16 | 18 | 18 | 8 | 10 |
| Low | 6 | 7 | 6 | 10 | 11 | 7 | 4 | 10 | 18 | 12 | 4 | 4 |
| **10. 5-Plane 1B 1D.** | | | | | | | | | | | | |
| High | 15 | 16 | 13 | 13 | 10 | 6 | 3 | 12 | 17 | 14 | 6 | 10 |
| Level | 12 | 15 | 13 | 14 | 13 | 14 | 10 | 18 | 21 | 14 | 4 | 9 |
| Low | 4 | 6 | 6 | 11 | 13 | 10 | 9 | 18 | 22 | 12 | 3 | 2 |
| **11. 5-Plane 2B.** | | | | | | | | | | | | |
| High | 13 | 15 | 12 | 14 | 12 | 7 | 4 | 12 | 18 | 12 | 4 | 7 |
| Level | 10 | 13 | 12 | 13 | 13 | 14 | 10 | 19 | 22 | 14 | 4 | 10 |
| Low | 3 | 4 | 4 | 8 | 10 | 9 | 9 | 18 | 23 | 14 | 6 | 4 |
| **12. 5-Plane 2D.** | | | | | | | | | | | | |
| High | 10 | 12 | 10 | 9 | 5 | 6 | 7 | 16 | 20 | 18 | 10 | 10 |
| Level | 11 | 14 | 12 | 11 | 9 | 11 | 9 | 18 | 20 | 17 | 8 | 11 |
| Low | 7 | 8 | 6 | 9 | 10 | 7 | 6 | 14 | 19 | 12 | 4 | 4 |
| **13. 6-Plane B.** | | | | | | | | | | | | |
| High | 16 | 18 | 15 | 17 | 13 | 7 | 4 | 14 | 21 | 15 | 6 | 11 |
| Level | 11 | 15 | 15 | 17 | 14 | 12 | 8 | 20 | 26 | 19 | 9 | 12 |
| Low | 3 | 5 | 6 | 10 | 11 | 8 | 9 | 19 | 26 | 17 | 8 | 5 |
| **14. 6-Plane D.** | | | | | | | | | | | | |
| High | 15 | 16 | 13 | 11 | 6 | 6 | 6 | 14 | 14 | 17 | 6 | 10 |
| Level | 16 | 18 | 15 | 14 | 10 | 10 | 8 | 17 | 16 | 16 | 8 | 13 |
| Low | 10 | 11 | 8 | 10 | 9 | 6 | 7 | 14 | 17 | 13 | 6 | 6 |
| **15. 6-Plane C Hi.** | | | | | | | | | | | | |
| High | 17 | 20 | 16 | 17 | 13 | 7 | 3 | 8 | 11 | 10 | 5 | 9 |
| Level | 14 | 15 | 14 | 14 | 14 | 16 | 10 | 19 | 22 | 15 | 6 | 10 |
| Low | 5 | 5 | 4 | 8 | 12 | 12 | 12 | 21 | 28 | 16 | 5 | 4 |
| **16. 6-Plane C Low.** | | | | | | | | | | | | |
| High | 9 | 8 | 7 | 7 | 5 | 5 | 8 | 23 | 29 | 25 | 13 | 13 |
| Level | 10 | 13 | 13 | 13 | 12 | 14 | 10 | 21 | 22 | 18 | 8 | 13 |
| Low | 7 | 10 | 9 | 13 | 14 | 10 | 8 | 14 | 20 | 10 | 3 | 4 |

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| | Nose | | | | | Beam | | Tail | | | Beam | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clock Angle | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **17. 7-Plane C Hi 1B.** | | | | | | | | | | | | |
| High | 20 | 25 | 19 | 21 | 16 | 8 | 4 | 9 | 14 | 10 | 4 | 10 |
| Level | 16 | 19 | 17 | 18 | 16 | 16 | 8 | 19 | 26 | 18 | 8 | 12 |
| Low | 6 | 7 | 6 | 9 | 11 | 11 | 12 | 22 | 32 | 20 | 7 | 5 |
| **18. 7-Plane C Low 1B.** | | | | | | | | | | | | |
| High | 13 | 12 | 10 | 11 | 9 | 7 | 8 | 24 | 32 | 26 | 13 | 15 |
| Level | 12 | 16 | 17 | 17 | 17 | 16 | 11 | 24 | 26 | 22 | 9 | 14 |
| Low | 7 | 11 | 11 | 16 | 17 | 11 | 8 | 16 | 26 | 14 | 4 | 4 |
| **19. 7-Plane 2B 2D.** | | | | | | | | | | | | |
| High | 16 | 19 | 17 | 16 | 11 | 7 | 6 | 18 | 25 | 20 | 8 | 11 |
| Level | 14 | 18 | 17 | 17 | 16 | 16 | 11 | 24 | 30 | 22 | 8 | 12 |
| Low | 6 | 7 | 6 | 12 | 15 | 12 | 12 | 22 | 31 | 18 | 6 | 4 |
| **20. 8-Plane 2B D** | | | | | | | | | | | | |
| High | 19 | 21 | 18 | 17 | 10 | 6 | 6 | 22 | 30 | 24 | 10 | 13 |
| Level | 18 | 22 | 20 | 21 | 15 | 12 | 12 | 28 | 34 | 26 | 10 | 16 |
| Low | 10 | 12 | 10 | 14 | 11 | 8 | 10 | 24 | 35 | 21 | 7 | 6 |
| **21. 8-Plane B 2D.** | | | | | | | | | | | | |
| High | 20 | 23 | 20 | 20 | 15 | 9 | 6 | 20 | 28 | 21 | 8 | 13 |
| Level | 16 | 21 | 20 | 21 | 18 | 18 | 12 | 28 | 33 | 22 | 8 | 13 |
| Low | 6 | 8 | 8 | 14 | 16 | 12 | 13 | 26 | 35 | 20 | 6 | 4 |
| **22. 8-Plane C Hi 1B 1D.** | | | | | | | | | | | | |
| High | 25 | 29 | 22 | 21 | 12 | 6 | 2 | 10 | 17 | 16 | 11 | 16 |
| Level | 18 | 21 | 19 | 18 | 17 | 20 | 13 | 25 | 30 | 20 | 9 | 13 |
| Low | 4 | 6 | 6 | 12 | 17 | 16 | 16 | 28 | 37 | 20 | 5 | 3 |
| **23. 8-Plane C Low 1B 1D.** | | | | | | | | | | | | |
| High | 17 | 16 | 13 | 13 | 10 | 8 | 8 | 26 | 35 | 30 | 15 | 18 |
| Level | 16 | 20 | 19 | 20 | 17 | 19 | 14 | 29 | 30 | 23 | 8 | 17 |
| Low | 8 | 12 | 12 | 18 | 19 | 14 | 14 | 24 | 29 | 14 | 3 | 4 |
| **24. 9-Plane B D.** | | | | | | | | | | | | |
| High | 23 | 25 | 21 | 21 | 15 | 9 | 6 | 24 | 33 | 26 | 10 | 15 |
| Level | 20 | 25 | 23 | 25 | 20 | 15 | 12 | 30 | 36 | 28 | 10 | 16 |
| Low | 10 | 13 | 12 | 17 | 16 | 9 | 10 | 26 | 38 | 24 | 8 | 6 |
| **25. 10-Plane C Hi 2B 2D.** | | | | | | | | | | | | |
| High | 28 | 33 | 27 | 25 | 13 | 7 | 5 | 16 | 24 | 20 | 13 | 19 |
| Level | 22 | 26 | 24 | 23 | 19 | 20 | 14 | 30 | 38 | 27 | 12 | 17 |
| Low | 7 | 9 | 8 | 14 | 18 | 15 | 15 | 31 | 45 | 27 | 8 | 5 |
| **26. 10-Plane C Low 2B 2D.** | | | | | | | | | | | | |
| High | 21 | 21 | 18 | 17 | 11 | 7 | 8 | 33 | 45 | 37 | 16 | 21 |
| Level | 18 | 24 | 24 | 25 | 22 | 18 | 14 | 34 | 37 | 31 | 9 | 20 |
| Low | 8 | 13 | 14 | 22 | 23 | 14 | 12 | 26 | 37 | 20 | 5 | 4 |



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| | Nose | | | | | Beam | | Tail | | | Beam | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clock Angle | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 27. 10-Plane 1C Hi B D. | | | | | | | | | | | | |
| High | 26 | 29 | 24 | 25 | 17 | 9 | 6 | 22 | 30 | 24 | 10 | 17 |
| Level | 22 | 27 | 25 | 27 | 22 | 17 | 13 | 30 | 38 | 29 | 12 | 20 |
| Low | 11 | 14 | 12 | 17 | 17 | 11 | 11 | 29 | 43 | 26 | 10 | 8 |
| 28. 10-Plane 1C Low B D. | | | | | | | | | | | | |
| High | 23 | 25 | 21 | 21 | 15 | 9 | 6 | 27 | 39 | 31 | 12 | 17 |
| Level | 20 | 27 | 25 | 27 | 22 | 16 | 12 | 31 | 38 | 30 | 11 | 18 |
| Low | 11 | 15 | 14 | 20 | 19 | 10 | 10 | 26 | 38 | 24 | 8 | 6 |
| 29. 11-Plane C Hi 2B D. | | | | | | | | | | | | |
| High | 28 | 33 | 27 | 25 | 13 | 7 | 5 | 20 | 30 | 26 | 14 | 19 |
| Level | 24 | 28 | 26 | 25 | 20 | 20 | 14 | 32 | 42 | 32 | 14 | 19 |
| Low | 10 | 12 | 10 | 16 | 19 | 15 | 15 | 32 | 49 | 30 | 10 | 7 |
| 30. 11-Plane C Low 2B D. | | | | | | | | | | | | |
| High | 21 | 21 | 18 | 17 | 11 | 7 | 6 | 32 | 48 | 40 | 18 | 21 |
| Level | 20 | 27 | 26 | 27 | 22 | 18 | 14 | 35 | 41 | 35 | 13 | 21 |
| Low | 12 | 17 | 16 | 24 | 24 | 14 | 12 | 27 | 41 | 24 | 7 | 6 |
| 31. 11-Plane 2C Hi B D. | | | | | | | | | | | | |
| High | 29 | 33 | 27 | 27 | 17 | 9 | 6 | 24 | 33 | 26 | 12 | 19 |
| Level | 24 | 29 | 27 | 28 | 22 | 19 | 16 | 35 | 42 | 30 | 12 | 18 |
| Low | 10 | 13 | 12 | 18 | 19 | 13 | 14 | 32 | 48 | 28 | 8 | 6 |
| 32. 11-Plane 2C Low B D. | | | | | | | | | | | | |
| High | 23 | 25 | 21 | 21 | 15 | 9 | 6 | 30 | 45 | 36 | 16 | 19 |
| Level | 20 | 28 | 27 | 29 | 22 | 17 | 13 | 35 | 41 | 35 | 14 | 20 |
| Low | 11 | 16 | 16 | 23 | 22 | 12 | 11 | 27 | 41 | 24 | 7 | 6 |
| 33. 11-Plane C Hi B 2D. | | | | | | | | | | | | |
| High | 32 | 37 | 30 | 29 | 17 | 9 | 5 | 18 | 27 | 22 | 13 | 21 |
| Level | 24 | 29 | 27 | 27 | 22 | 21 | 16 | 32 | 40 | 28 | 12 | 18 |
| Low | 7 | 10 | 10 | 16 | 19 | 15 | 16 | 33 | 46 | 27 | 8 | 5 |
| 34. 11-Plane C Low B 2D. | | | | | | | | | | | | |
| High | 25 | 25 | 21 | 21 | 15 | 9 | 6 | 30 | 45 | 36 | 17 | 23 |
| Level | 20 | 27 | 27 | 29 | 24 | 19 | 15 | 36 | 41 | 31 | 10 | 20 |
| Low | 8 | 14 | 16 | 24 | 24 | 14 | 13 | 29 | 41 | 22 | 5 | 4 |
| 35. 12-Plane C Hi B D. | | | | | | | | | | | | |
| High | 32 | 37 | 30 | 29 | 17 | 9 | 5 | 24 | 39 | 30 | 14 | 18 |
| Level | 26 | 31 | 29 | 30 | 24 | 21 | 16 | 37 | 48 | 35 | 16 | 20 |
| Low | 10 | 13 | 12 | 18 | 20 | 15 | 16 | 36 | 53 | 32 | 10 | 7 |
| 36. 12-Plane C Low B D. | | | | | | | | | | | | |
| High | 25 | 25 | 21 | 21 | 15 | 9 | 6 | 34 | 51 | 42 | 18 | 22 |
| Level | 22 | 29 | 29 | 31 | 22 | 12 | 7 | 30 | 41 | 37 | 13 | 22 |
| Low | 11 | 17 | 18 | 22 | 17 | 6 | 6 | 22 | 41 | 26 | 7 | 6 |

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RADIUS FRAMING FOR SUPPORT FIRE.

( Instructions for Gunnery Officers )

Stemming from the initial emphasis on position firing before a CFC System was available, gunnery training has tended to concentrate upon teaching a gunner how to track, range and fire at a fighter which is attacking his own ship. This not only denies the whole purpose of formation flying to attain mutual fire support, but also means that the typical gunner is likely to use a technique of framing his target which renders him ineffective when he does try to provide support fire. A solution to the problem is illustrated by the attached photographs.

The first illustration shows five aspects of a Jap fighter, all taken at the same range. View Number 1 shows a fighter with guns bearing, which the gunner has been taught to frame correctly, centering his pipper, and enclosing the wing tips within the circle of hisreticle.

Views 2, 3, 4, and 5, show aspects of a fighter which is not attacking him, but against which his support fire may be needed.

A white X indicates the point on which he is likely to place his pipper, and a black circle shows the likely range he will feed into his computer. It is apparent that his tendency to enclose the plane, regardless of its aspect, causes serious underframing and overranging.

The white dots show how he should place his pipper on the center of the fuselage at the leading edge of the wing, and frame the target so that the outside circle just encloses the part of the fighter farthest from the pipper. (The radius of the circle should equal the largest dimension from the aiming point.) With this technique it is apparent that he will not only center the target properly, but also he will feed in much more nearly the correct range.

It is recommended that this principle be taught all gunners, and that the second illustration, showing the correct framing technique for support fire, be reproduced for this purpose.



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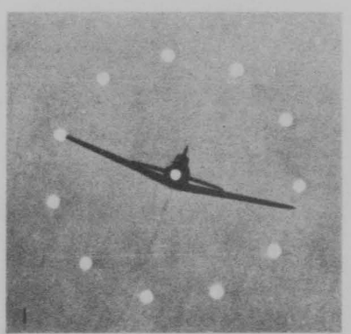
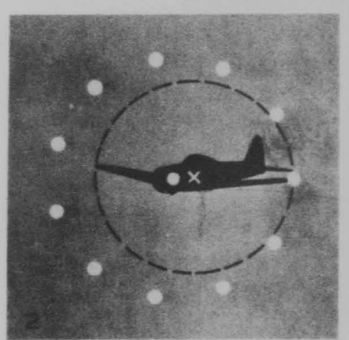
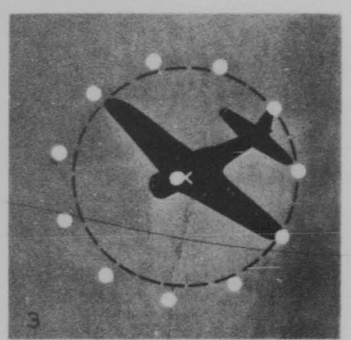
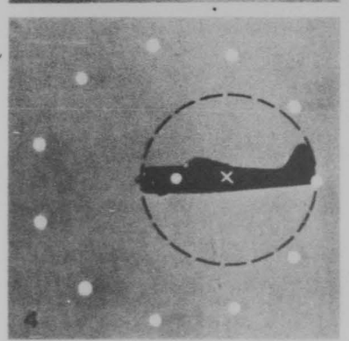
TECHNIQUE OF RANGING

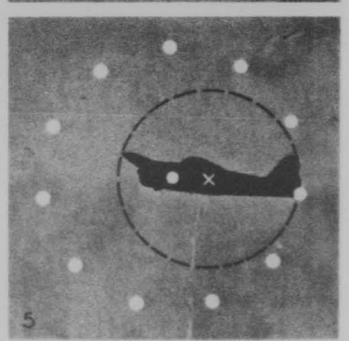
Comparison of Present Methods of Ranging with Recommended Method of Radius Framing for Support Fire




Note how present method consistently underframes

Legend: Dotted black line...Present Method
White dots.....Recommended Method

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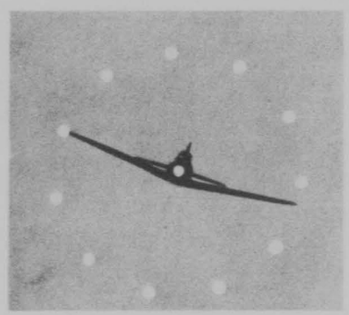
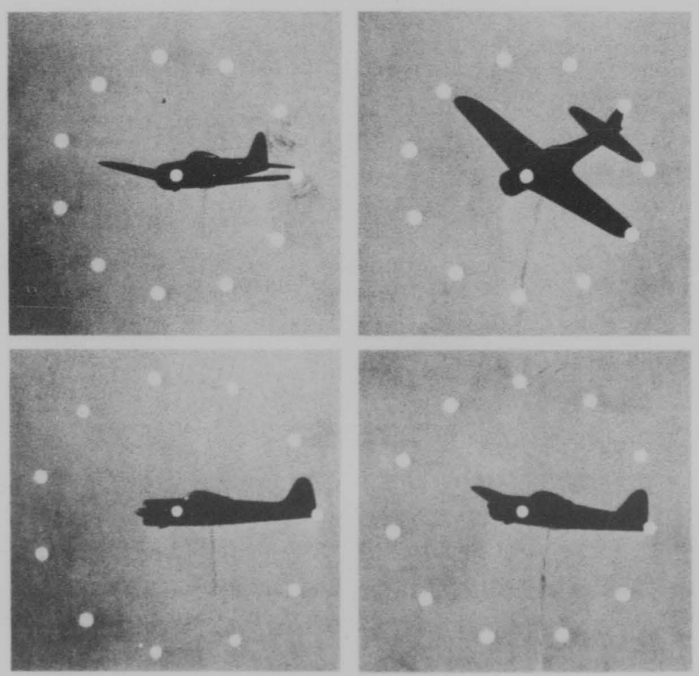
# to HIT that FIGHTER

**ALWAYS** Put the Pipper on the Middle of his Fuselage at the Leading Edge of his Wing Roughly on the Pilot's **FANNY**



**ALWAYS** Frame him so the Circle of your Reticle just Touches Whatever part is Farthest from the **PIPPER**



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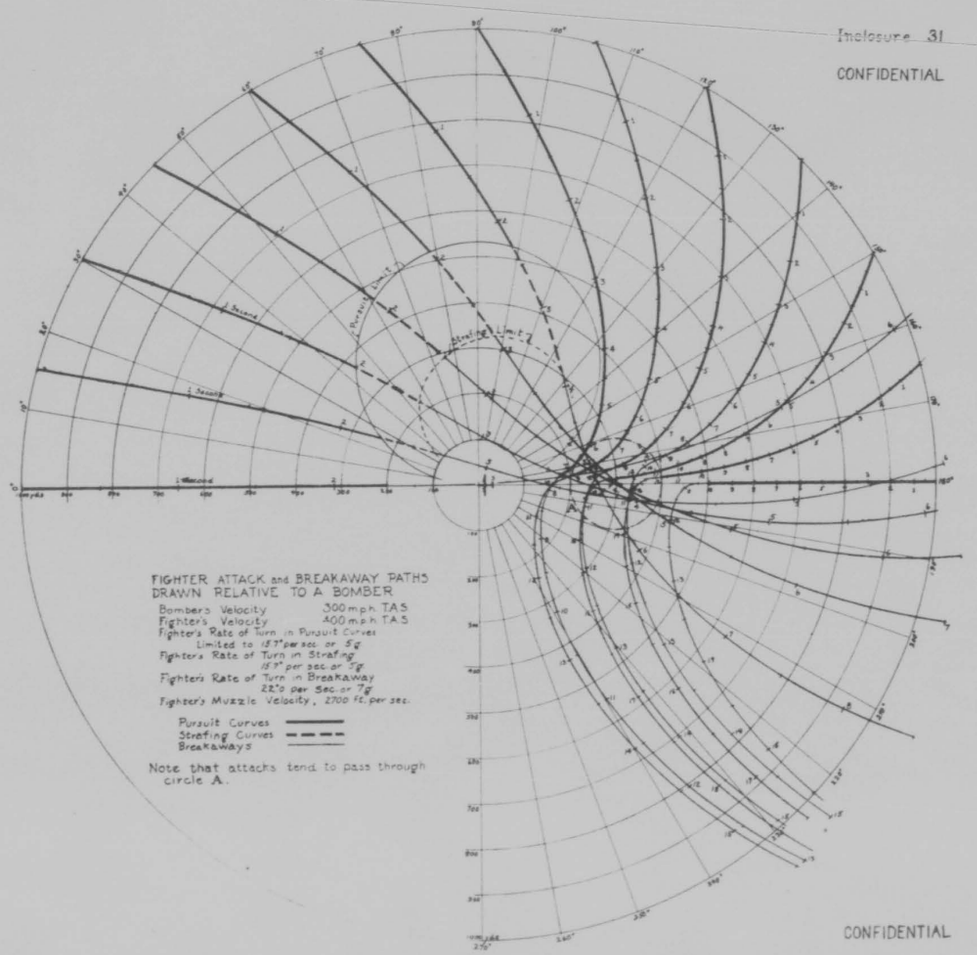


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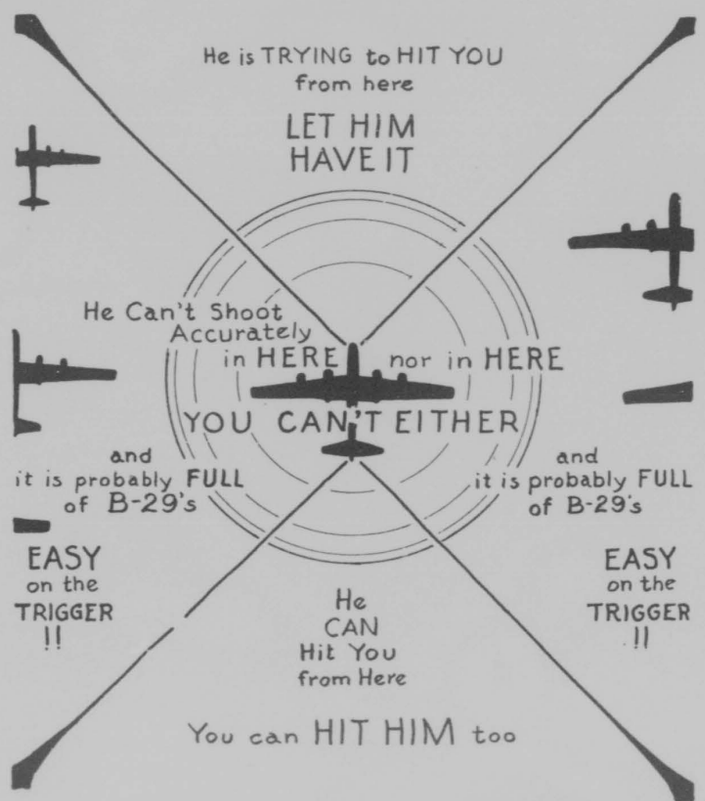
SUGGESTED POSTER TO INDOCTRINATE GUNNERS
IN THE RULES FOR EFFECTIVE GUNNERY




-RULES-
for
Effective Gunnery

| from the Front | from the Rear | from the Side |
|---|---|---|
| FIRE | FIRE | SAVE IT |

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HEADQUARTERS TWENTIETH AIR FORCE
OPERATIONS ANALYSIS DIVISION

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4 July 1945

# CALIBRATION OF THE B-29 COMPUTER FOR TAIL DEFENSE

## I. Summary and Recommendations

1. It has been known for a long time that the General Electric computers in the B-29 tail, blister, and ring sighting stations are not ideally calibrated for shooting against tail attacks. First, the computer is slow in building up its lead, and second, it has a strong tendency to overlead after the lead is built up.

2. During the past two months, a large number of tests have been conducted by the War Research Laboratory, University of Texas (under Section 7.2, NDRC), to determine what changes should be made in the computer to provide quicker setting up of lead and maintenance of correct lead after the leads are set up. The only modifications given a complete test were those which can easily be carried out in a combat Theater and with very little additional equipment. Other, more complicated modifications, which may improve the computer's performance still further, will be tested as soon as possible and submitted as possible factory modifications.

3. While the University of Texas testing machine is the best laboratory machine in the United States for testing aerial gunnery systems, it cannot duplicate exactly conditions in the air. Ideal computer modifications, taking account of poor tracking by average gunners, variations in fighter speeds and modes of attack, and differences between computer performance in the laboratory and in the air, are probably somewhat different from

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those recommended in this report. Nevertheless, the probable improvements according to the Texas machine tests are so striking that they can be recommended without reservation to the operational Commands. The extremely limited amount of available air test data does not agree exactly with the Texas machine data, but it indicates that the changes recommended are in the right direction and of essentially the right amount.

4. Details of the recommended modifications to the B-29 computer for tail defense are found in Section IV, Para. 1, of the present report. It is recommended that the operational Commands using B-29 airplanes modify tail, blister, and ring sighting station computers as there described. It is clear that adoption of this measure will result in vastly improved defense of B-29 airplanes against tail attacks.

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## II. Modifications tested or considered

1. The present computer. The General Electric computer in present use computes its kinematic lead by measuring the angular rate of the target as determined from the operator's tracking and multiplying this angular rate by 1.07 times the time of flight as determined from the range inputs. Leads are computed independently in azimuth and elevation. The computer varies the amount of lead put in by means of azimuth and elevation total correction motors, which have two speeds. These speeds can be adjusted to any values between 0 and 100 mils per second. High or low speed operation of the total correction motors is determined by a time delay unit in the computer: when any one of the gyro contacts in the sighting station stays closed for the period of the time delay, the total correction motors will shift automatically from low to high speed, and will stay in high speed until the gyro contact opens. The normal computer has approximately 35 mils/sec. low speed, 60 mils/sec. high speed, and a time delay of 1.5 seconds.

2. Percentage of time of flight. The most important variable in computing lead for tail attacks is the percentage of time of flight which the computer uses to determine its kinematic lead, and which is at present 107%, as mentioned in para. 1. This percentage of time of flight can be changed in at least three ways:

a) by increasing or decreasing the regulated voltage (normally 22.25 volts) in the time of flight network; this will change the percentage of time of flight by a constant factor, according to the following equation:

$$\text{New Percentage of time of flight} = \frac{22.25}{\text{New regulated voltage}} \times 107$$

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b) by inserting a fixed resistance of x ohms in the time of flight network in parallel with resistance R850 in that network. This gives a variable reduction in percentage of time of flight. It is large at long range and negligible at short range.

c) by inserting a resistance $r_c$ in the low range end of the range receiving potentiometer in the computer and another resistance $r_s$ in the long range end of the range transmitting potentiometer in the sight. The resistance $r_s$ is to be inserted between R7 and line 30 in the sight, and resistance $r_c$ is to be inserted between resistance R848 and line 932 in the computer. If $r_s$ is 50% larger than $r_c$, this change will yield a fixed percentage reduction in the range fed to the computer and hence a fixed reduction in time of flight. The percentage of time of flight obtained is given by the equation:

$$\text{Percentage of time of flight} = 107 \times 10^{-r_c/6120}$$

This equation is derived in Appendix 2.

It is believed that modification a) is not desirable because the nose computer, which is supplied with regulated voltage from the same voltage regulator as the tail, blister, and ring sight computers, needs the normal 22.25 volts for its operation. If all the computers except the nose computer were removed from the voltage regulator, it would be difficult to make the voltage regulator operate accurately with a load of only one computer on it. Modification b) was held to be unsatisfactory because of the variable effect at different ranges and undetermined effect on the fixed range necessary for the ring sight gunner to use when firing ahead. On the other hand, modification c) is ideal. As it reduces by a constant percentage the range given to the computer, it improves the bullet trail and bullet drop corrections.

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It is very easy to carry out and needs only two resistors for each computer-sight combination. For the ring sight, it permits firing ahead with a new fixed range at the sight, which will give exactly the same results in the computer as fixed range with the modified nose computer, provided only that the fixed range at the sight is chosen to fit the percentage reduction in range.

3. Variation in percentage of time of flight. A constant percentage of time of flight can be selected which will yield excellent results for most conceivable attacks on the airplane that is doing the shooting. However, for many support fire shots and for some breakaways (if any shooting can be done at breakaways), the percentage of time of flight should be different from that used for attacks on the firing airplane. A modification of the time delay unit has been suggested and given preliminary test by Dr. L. A. Jeffress of the War Research Laboratory, University of Texas, which will indeed give two different percentages of time of flight, depending upon whether or not the leads are increasing or decreasing. This device may give still further improvements in B-29 defense, but it requires too complicated a modification for combat Theater personnel to carry out. It will be given further test and if found to yield large returns will be recommended for a factory modification on production computers.

4. Correction motor speeds. A second important variable factor in computer operation is the speeds at which the correction motors run. If their speeds are too slow, the computer will have difficulty in building up or reducing leads, and if they are too fast, the computer will see-saw or hunt about the correct lead and yield very few hits. The two speeds of the total correction motors can be varied at will by moving taps up and down on the resistance R890 in the computer.

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5. Time delay. Finally, the time delay which must expire before the total output motors shift from low to high speed can be varied at will by insertion of resistors in place of or in parallel with resistors R861 and R862 in the time delay unit. If the time delay is too large, the motors will go into high speed only under very exceptional conditions, and the benefits of high speed operation will be lost. If the time delay is too small, the motors will go into high speed operation for short intervals of time when the gunner is tracking and the loads are already built up. This is of no benefit, as high speed operation will often overcorrect and cause large lead errors.

6. All of the computer modifications discussed in paras. 2-5 above were given tests on the University of Texas testing machine. In addition, certain other suggestions were received but discarded because of considerations arising from production and operation difficulties or probable unsuitability for combat conditions. These suggestions were:

a) to run the computer with 125% of time of flight computation while the time delay operates and with 85% thereafter (discarded because of the undependable character of high speed operation);

b) to fit a device on the computer so that it always has an own speed load (depending only on bomber speed and angle off of the gun turret) at the beginning of each attack (discarded because of production difficulties);

c) to run the computer with 125% of time of flight computation for a short period of time starting whenever the gunner presses the trigger (discarded because of the known unpredictability of gunners' combat performance);

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d) to run the computer in high speed for a short period of time after the gunner presses the trigger and thereafter in low speed (discarded for the reason given for c) above);

c) to run the computer in high speed except when the gunner is firing (discarded for the reason given for c) above).

## III. Details of Tests

1. Technical Personnel. The tests of modifications described in Section II above were conducted during the period 25 May 1945--4 July 1945. They were conducted jointly by personnel of the War Research Laboratory, University of Texas, representatives of the General Electric Company, and the undersigned. The personnel concerned of the War Research Laboratory and the principal representative of the General Electric Company (the other two having left before the completion of the test) are in complete agreement with the conclusions and recommendations of the present report.

2. The testing machine. The machine used in the tests is a mechanism which can duplicate azimuth and elevation movements, as well as range, for any fixed fighter course. The gunner sees a motion picture of a fighter aircraft, which moves in azimuth and elevation in a prescribed manner. He tracks (and ranges where necessary) this target with the sighting equipment used in the air. His sight is connected to whatever computer is being tested, which in turn transmits the lead information to a standard turret. By a system of gimbals, the turret gun position is compared with the correct gun position (which is known for the fixed fighter course being duplicated by the machine). Errors in azimuth (actually traverse instead of azimuth error), elevation, and range (where range is used) are automatically recorded on photographic paper, and can be studied within a few minutes after the test





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has been made. The errors committed by the machine in measuring gun position errors are from one to two mils.

3. Gunners. Six gunners were used in the test. These men are on temporary duty at the War Research Laboratory, University of Texas, from Laredo Army Air Field, Laredo, Texas. Five of them have had extensive combat experience, four having completed tours of operations and one having completed 13 missions before being shot down. Two were turret gunners on B-17 airplanes, two were turret gunners on B-24 airplanes, and one was a turret gunner on a B-25 airplane. The sixth gunner has not had combat experience but, having been a gunnery school instructor for a long period, is thoroughly versed in aerial gunnery technique. Four of the gunners have had a truly enormous amount of practice in tracking and ranging with the General Electric pedestal sight, while the two others have had less but still a large amount of practice. No differences could be detected among the results obtained by the four highly experienced gunners, and only small differences in tracking and ranging between them and the less experienced gunners. There were no differences between the two sets of gunners in final results with the computer. Typical tracking errors are shown in Figure 24, Appendix 1.

4. Fighter courses. Four different fighter courses were used in the test. Specifications for these courses follow:

Course 1. A pursuit course starting slightly ahead of the beam, ending on the tail, and lying in a plane tilted 30° above horizontal. Fighter flies with constant TAS of 300 MPH, always flying directly at the bomber without any lead. Bomber speed is 180 MPH IAS, altitude 7500 feet.

Course 2. A straight line course starting at about 7 o'clock high, and crossing over the bomber's line of flight at about 250 yards. Fighter speed, bomber

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speed, and altitude are the same as for course 1.

Course 4. A pursuit course in a horizontal plane starting at about 3 o'clock level and ending up at nearly six o'clock level. Fighter flies with constant TAS of 315 MPH, always flying directly at the bomber without any lead. Bomber speed is 159 MPH IAS, altitude 22,000 feet.

Course 12. A pursuit course starting at about 4:30 high and ending at nearly 6 o'clock level. Fighter flies with airspeed slightly variable, starting with 500 MPH TAS. Path lies in plane tilted by varying amounts during the attack. Bomber speed is 234 MPH IAS; altitude is 32,000 feet.

The conditions of courses 1 and 2 are close enough to current B-29 operating airspeeds and altitudes to make results for these courses unquestionably valid for B-29 combat use. Course 4 has true airspeeds close to those of current B-29 operations. The leads from the bomber in course 4 approximate closely the leads found for attack courses on B-29s for current operating altitudes, and it may be inferred that computer performance for course 4 will be reasonably close to actual computer performance under present combat conditions. Course 12 is enormously different from any course which could be flown against B-29s under present conditions. A fighter speed of 500 MPH TAS could possibly be attained in a dive, but the bomber true airspeed (385 MPH) is of course out of the question. The leads in this course are much larger, for a given fighter position, than they would be for any attack course against a B-29 under present conditions. Course 12 was therefore used only as a check on the results found with courses 1, 2, and 4.

5. Computers. Three different computers were used during the test, one being a double parallax computer, model 2CH1D3-R, serial number 1579964, and the other two being single parallax computers model 2CH1C3-N, serial numbers 1574487 and 1574255. Computer 1579964 was brought to the War Research Labora-

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tory, University of Texas, for the purpose of comparing its ground operation with its operation in the air at the General Electric Flight Test project in Brownsville, Texas. A comparative check was made of the three computers, and they were found to be virtually identical in their operation when adjusted properly. Accordingly, computer 1579964 was used throughout most of the test. It was checked each day by an authorized representative of the General Electric Company before being used for test.

6. Test program. As stated in Section II above, the tests under discussion were primarily concerned with determining optimum output motor speeds, percentage of time of flight, and time delay periods. The following percentages of time of flight were used: 107 (normal computer), 90, 85, 80, and 75. The following low speeds for the total correction motors were used: 40 mils/sec., 50 mils/sec., 60 mils/sec., 70 mils/sec., 80 mils/sec., and 90 mils/sec. High speed was kept constant at 100 mils/sec. Three different values for the time delay period were tested: 1.5 seconds (normal computer), .7 seconds, and .3 seconds. Not all of the gunners were run on each course with each possible modification, as the labor attendant upon such a program would have been prohibitive. Rather, a process of successive approximations was employed, which involved trying out the effect of the various modifications with two or three gunners, and selecting optimum values of time delay period and correction motor speeds before making an exhaustive test of possible percentages of time of flight.

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## IV. Details of results

1. Summary. The results obtained from the tests and the recommendations for combat theater modification to the computer can be summarized as follows:

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a) Change the percentage of time of flight from 107% to 85% by the addition of two resistances. A resistance of 900 ohms is to be added in series to the long range end of the range transmitting potentiometer in the sight, between R7 and lead 30. A resistance of 600 ohms is to be added at the short range end of the range receiving potentiometer in the computer, between R848 and lead 932.

b) Change the low and high speeds of the total correction motors from 35 mils/sec. (with tolerance above of 15 mils/sec. and no tolerance below) and 60 mils/sec.(with tolerance above of 30 mils/sec. and no tolerance below) to 60 (with tolerance above of 20 mils/sec. and no tolerance below) and high speed corresponding to full voltage. This is done simply by readjusting low speed in the usual manner (GEI 18787A, pages 200-201) and putting the present high speed wire on the upper end of resistor R890.

c) Reduce the time delay from 1.5 seconds to .7 seconds by adding 1 megohm resistances in parallel with resistances R861 and R862 in the time delay unit.

d) Instruct the ring sight gunner to set 1125 yards fixed range into his sight when firing at nose attacks. A range of 900 yards $\left(\frac{.85}{1.07} \times 1125 = 893 \text{ yards} \sim 900 \text{ yards}\right)$ will be sent to the computer, which will then put in leads which are very good for nose attacks (see 20AF OAD report, 28 April 1945, "Tests of B-29 Computers for Nose Defense on the University of Texas Testing Machine.")

Modifications a) and b) are the most important, and must be carried out if the computer is to do the best possible work in tail defense. Modification c) is of secondary importance.

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2. Optimum correction motor speeds. The computer was found to be comparatively insensitive to changes in correction motor speeds. It is hard to discover any difference in time required to build up lead between 50 and 60 mils/sec. or between 60 and 70 mils/sec. On the other hand, operation at 40 mils/sec. does give a perceptibly increased time for the computer to build up correct leads. As pointed out in Section II, para. 4, operation at too high correction motor speeds makes the computer hunt excessively, never settling onto the correct lead. At 70 mils/sec. correction motor speed, there is a discernible tendency to hunt, while the time required to get onto the problem is not discernibly smaller than the time required with 60 mils/sec. correction motor speed. At 80 and 90 mils/sec., the computer hunts very noticeably. This is shown in Figure 22, Appendix 2. 60 mils/sec., therefore, was selected as the ideal correction motor speed.

3. Optimum time delay period. As indicated in Section II, para. 5, the high speed feature of the correction motors would be valueless if the time delay were too long. This was found to be the case with 1.5 seconds time delay. The correction motors never got into high speed operation, except when the gunner slewed the sight for 1.5 seconds or longer or if there were very large incorrect leads in the computer. With .7 seconds time delay, the correction motors have a chance to get into high speed operation when the gunner is slewing, which is a valuable feature when the operator is slewing in the direction of motion of the fighter. On the other hand, .7 seconds time delay does not allow the correction motors to go into high speed operation while the gunner is tracking a target, and this again is highly desirable. With a time delay of .3 seconds, the correction motors will go into high speed operation whenever the gunner slews, but they also continually go into high speed when the gunner is tracking his target and the correct leads are already set

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up. This is most undesirable, as the result is often to introduce large errors in lead. The effects of .3 second time delay are shown clearly in Figure 23, Appendix 1. It was decided, therefore, that .7 seconds time delay is the best to use.

4. Optimum percentage of time of flight. With correction motor speeds of 60 and 100 mils/sec., and time delay of .7 seconds, an exhaustive test was made on courses 1, 2, 4, and 12 to determine the best percentage of time of flight to use. It is clear that 85% of time of flight gives results which are enormously better than those obtainable with the normal computer. A photographic record of these results is set forth in figures 1-18 of Appendix 1. There was no great difference between 85% and 90%, but as other evidence shows that the lower figure may be superior, it was used. (See para. 5, below.)

5. Differences between air and ground operation. Records of computer performance and of correct kinematic lead for six passes in the air at the General Electric Flight Test Project at Brownsville, Texas, were available for study, three with correction motors running at 60 mils/sec. low speed and three with the correction motors running at 35 mils/sec. low speed. The three passes with 60 mils/sec. low speed showed the computer to be very slow in building up its lead and very slow in decreasing the lead after it was built up, always overleading, even above the figure of 1.07 x time of flight x angular rate. The computer (serial number 1579964) and pedestal sight used in the Brownsville test were brought to Austin and given thorough tests. The azimuth gyro on the Brownsville computer failed in the middle of the test and was replaced with a gyro on hand at the War Research Laboratory. It was found impossible to duplicate in the laboratory the peculiar behavior noted in the Brownsville tests, even with various types of shaking applied to the sight in order to simulate vibration of the airplane. On course 1, the computer settled

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down to about 90% of the theoretical lead, which is 1.07 x time of flight x angular rate. On course 4, the computer settled down to about 98% of 1.07 x time of flight x angular rate. From the Brownsville air test data, one would conclude that 75% of time of flight would be the correct percentage to use. This is not in agreement with the results obtained from the testing machine, or from the computer records themselves in the laboratory. (See para. 4 above and figures 1-18 of Appendix 1.) It was decided, in the face of this apparent anomaly, to recommend 85% of time of flight as being certainly safe and in the right direction. As the three passes for which records are available cannot be considered conclusive, and as there appears to be no possibility of obtaining conclusive air test data within a reasonable time, 85% of time of flight is recommended to the operational Commands as being very close to the correct answer if not exactly correct.

6. Probable benefits from radar ranging. On beam and tail attacks, where the transients in the mechanism's action have a chance to die out, the General Electric computer behaves just about as it was designed to behave: it measures the angular rate, multiplies it by some percentage of the time of flight, and puts that amount in as kinematic lead. If the correct percentage of time of flight is selected (see para. 4 above), and if the range is correct, the computer will put in the right lead. On the other hand, errors in range are immediately reflected in lead errors of the same percentage size. This is clearly shown by figures 1, 2, 4, 5, 7, 8, 11, 12, 14, and 15, in Appendix 1. It should be noted that these passes were selected to show bad ranging and are not the average performance of the gunner who was operating the sight. It must be expected, however, that combat performance will not be very much better than the ranging performance shown in the above-mentioned figures. It may be deduced from this that radar ranging will yield enormous benefits in beam and tail defense of the B-29.

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7. Suggestions regarding gunner technique. From the tests described above, additional confirmation has been obtained for certain facts about gunner technique which have long been known but which perhaps deserve repetition.

a) If the gunner can slew onto his target in the direction of relative motion of the target, putting too large an angular rate into the computer, but keeping his sight movement smooth, he will build up the correct lead much faster than if he jerks onto the target and then starts tracking. (This is known as the Hunsen effect.)

b) The gunner should point his sight, when at rest, so that he will be in the best position for slewing in the direction of relative motion of probable targets. If, however, he needs to slew in the opposite direction, he can avoid setting up spurious leads by keeping the action switch open while slewing and closing it only when he has reached the target.

c) Smooth tracking and good ranging, especially good ranging, will pay off.

d) Radar ranging will yield large benefits.

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## Appendix 1

## Photographic Records

The records which follow (Figures 1-24) show one gunner's performance with modified and normal computers and manual and automatic correct range inputs on courses 1, 2, 4, and 12. Course 12 was run only with correct range inputs because it had become quite obvious that the effect of using manual range was only to obscure the effect of the modification under test: under-ranging makes under-leading and over-ranging makes over-leading. Course 2, which is a straight line course, was checked only with the modified computer and correct range inputs to be sure that the modified computer, which is designed primarily for attack courses (i.e., courses more or less like pursuit courses, in which the fighter flies a curved path) will also hit straight line courses when the leads are not too large.

At the top of each graph, there is a range scale in hundreds of yards. On each graph, the curves marked "A" show the azimuth error (actually the traverse error), the curves marked "E" show the elevation error, and the curves marked "R" show the range error in percent of correct range. The parallel vertical lines are $\frac{1}{2}$-second time intervals.

On all courses, the range error curves indicate too short range when the curve is below the zero line and too long range when the curve is above the zero line. The scale is 20 percent for every ten-mil division on the gun error scale at the left of each graph.

The azimuth error curves on courses 1, 4, and 12 indicate too much lead when the curve is above the zero line and too little lead when the curve is below the zero line. On course 2, the azimuth error curves indicate too little lead when the curve is above the zero line and too much lead when the curve is below the zero line.

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On all courses, the elevation error curve indicates too much elevation lead when the curve is below the zero line and too little elevation lead when the curve is above the zero line.

No range error curve will be found, naturally, on the graphs showing computer performance with automatic correct range inputs.

There are two auxiliary lines at the bottom of each graph. The uppermost of these consists of a series of broken lines. When the broken line is displaced upward, the gunner was depressing the trigger. The lower auxiliary line is a wavy line with occasional displacements downward. These downward displacements indicate high speed action of the correction motors.

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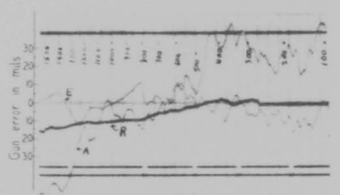


Figure 1. Course 1, manual ranging, normal computer

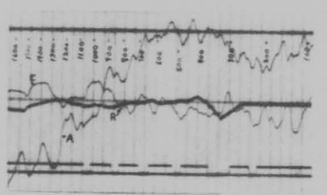


Figure 2. Course1, manual ranging, normal computer

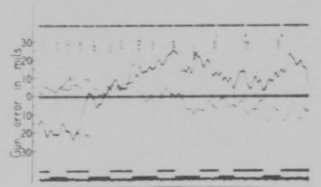


Figure 3. Course 1, automatic correct range inputs, normal computer

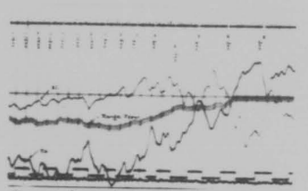

Figure 4. Course 1, manual range, modified computer

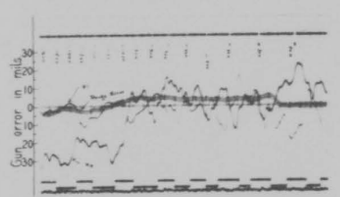


Figure 5. Course 1, manual range, modified computer

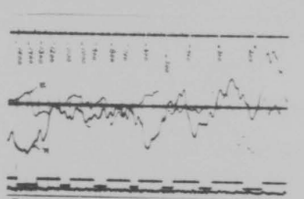

Figure 6. Course 1, automatic correct range inputs, modified computer

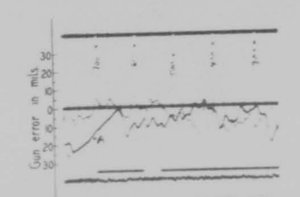


Figure 7. Course 2, manual range, normal computer

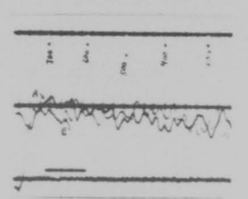

Figure 8. Course 2, manual range, normal computer

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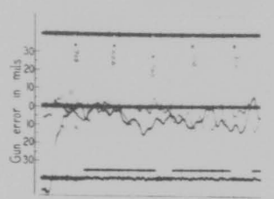


Figure 9. Course 2, automatic correct range inputs, normal computer.

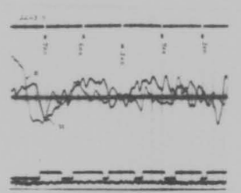

Figure 10. Course 2, automatic correct range inputs, modified computer.

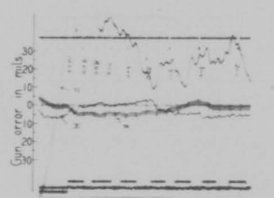


Figure 11. Course 4, manual range, normal computer.

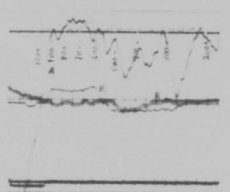

Figure 12. Course 4, manual range, normal computer.

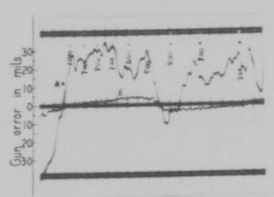


Figure 13. Course 4, automatic correct range inputs, normal computer.

Figure 14. Course 4, manual range, modified computer.

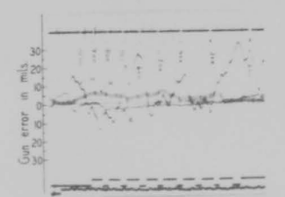


Figure 15. Course 4, manual range, modified computer.

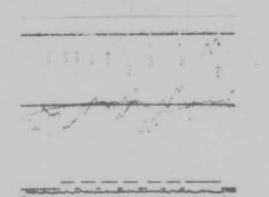

Figure 16. Course 4, automatic correct range inputs, modified computer.

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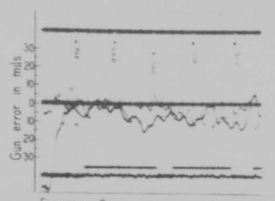



Figure 9. Course 2, automatic correct range inputs, normal computer.

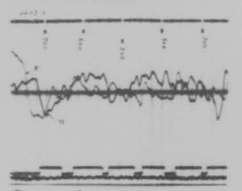


Figure 10. Course 2, automatic correct range inputs, modified computer.

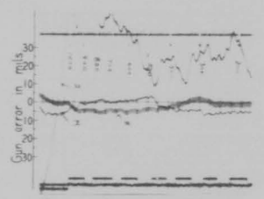



Figure 11. Course 4, manual range, normal computer.

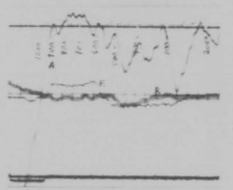


Figure 12. Course 4, manual range, normal computer.

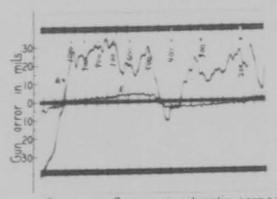
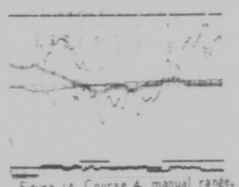



Figure 13. Course 4, automatic correct range inputs, normal computer.



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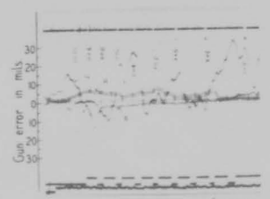


Figure 15. Course 4, manual range, modified computer.

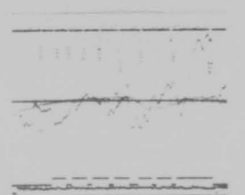

Figure 16. Course 4, automatic correct range inputs, modified computer.

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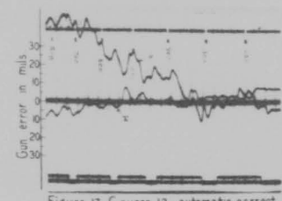


Figure 17. Course 12, automatic correct range inputs, normal computer.

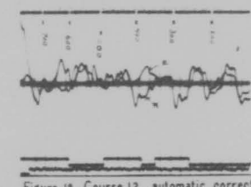

Figure 18. Course 12, automatic correct range inputs, modified computer.

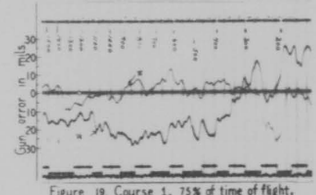


Figure 19. Course 1, 75% of time of flight, 60 & 100 mils/sec. output motors, .7 sec. time delay, automatic correct range inputs.

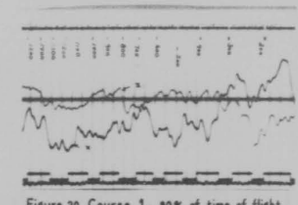

Figure 20. Course 1, 80% of time of flight, 60 & 100 mils/sec. output motors, .7 sec. time delay, automatic correct range inputs.

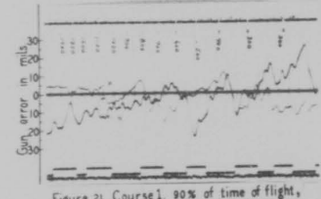


Figure 21. Course 1. 90% of time of flight, 60 & 100 mils/sec. output motors, .7 sec. time delay, automatic correct range inputs.

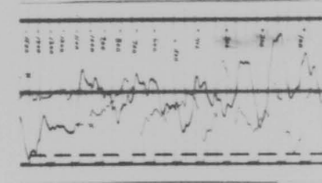

Figure 22. Course 1, 85% of time of flight, 90 mils/sec. output motors (no high speed), automatic correct range inputs.

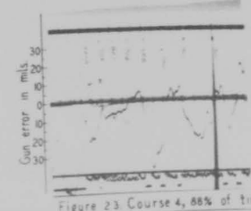


Figure 23. Course 4, 88% of time of flight, 60 & 100 mils/sec. output motor, .3 sec. time delay, automatic correct range inputs.

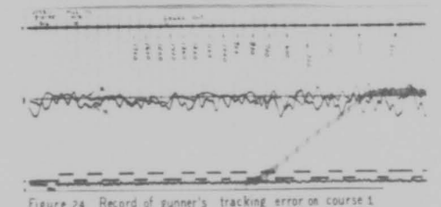

Figure 24. Record of gunner's tracking error on course 1. (Thick line has no significance.)

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Appendix 2

Derivation of the equations for reduction in percentage of time of flight.

The following notation is used:

$R_i$ = range input, i.e., range according to the reflector sight;

$R_o$ = range output, i.e., range according to the computer;

$r_s$ = resistance added in series to the long range end of the range transmitting potentiometer, R7;

$r_c$ = resistance added in series to the short range end of the range receiving potentiometer, R848;

$r_i$ = resistance between slider on R7 and short range end of R7;

$r_o$ = resistance between slider on R848 and short range end of R848.

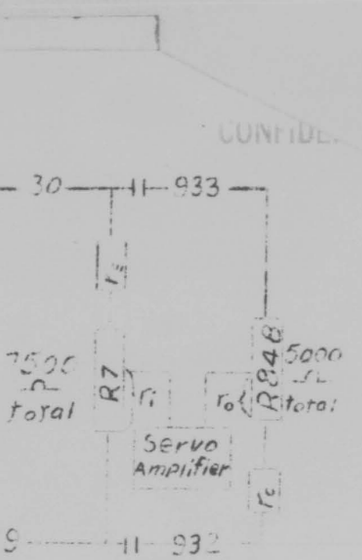


Figure 25

All logarithms used in the following discussion are taken to the base 10.

The input motions to the range transmitting and receiving potentiometers R7 and R846 are logarithmic in character, according to General Electric Company data.

The range input $R_i$ and the resistance $r_i$ are connected by the following equation:

(1) $r_i = 9190 \log \left(\frac{R_i}{250}\right) + 165.$

Hence

(2) $r_i = 9190 \log (.00417 R_i).$

Similarly, we have:

(3) $r_o = 6120 \log \left(\frac{R_o}{250}\right) + 110,$

and

(4) $r_o = 6120 \log (.00417 R_o).$

(See General Electric Publication GEI 18787A, p. 91, for values to verify these equations.)

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The resistance $r_o$ is determined by the value of resistance $r_i$ (see Figure 25). As the system is, in effect, a Wheatstone bridge, the resistances above and below the sliders (see Figure 25) must be proportional. Hence we have the following equation:

$$(5)\quad \frac{r_s + 7500 - r_i}{r_i} = \frac{5000 - r_o}{r_o + r_c}$$

Solving equation (5) for $r_o$ in terms of $r_i$, $r_s$, and $r_c$, we find

$$(6)\quad (r_o + r_c)(r_s + 7500 - r_i) = r_i (5000 - r_o)$$

$$(7)\quad r_o (r_s + 7500) = r_i (5000 + r_c) - r_c (r_s + 7500)$$

$$(8)\quad r_o = \frac{5000 + r_c}{7500 + r_s} r_i - r_c$$

Substituting the values for $r_o$ and $r_i$ from equations (4) and (2), we find

$$(9)\quad \log (.00417\, R_o) = \frac{9190}{6120} \times \frac{5000 + r_c}{7500 + r_s} \log (.00417\, R_i) \frac{-r_c}{6120}$$

If $r_s = 1.5\, r_c$, equation (9) reduces to

$$(10)\quad \log (.00417\, R_o) = \log (.00417\, R_i) - \frac{r_c}{6120}, \text{ or}$$

$$(11)\quad \log \frac{(R_o)}{(R_i)} = - \frac{r_c}{6120}$$

Hence

$$(12)\quad \frac{R_o}{R_i} = 10^{-r_c/6120}$$

As the computer normally uses 1.07 x time of flight and as the time of flight is nearly proportional to range, equation (12) shows that the percentage of time of flight obtained with resistances $r_c$ and $r_s = 1.5\, r_c$ is

$$1.07 \frac{R_o}{R_i} = 1.07 \times 10^{-r_c/6120}.$$

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Reports and Memoranda
VOL. II



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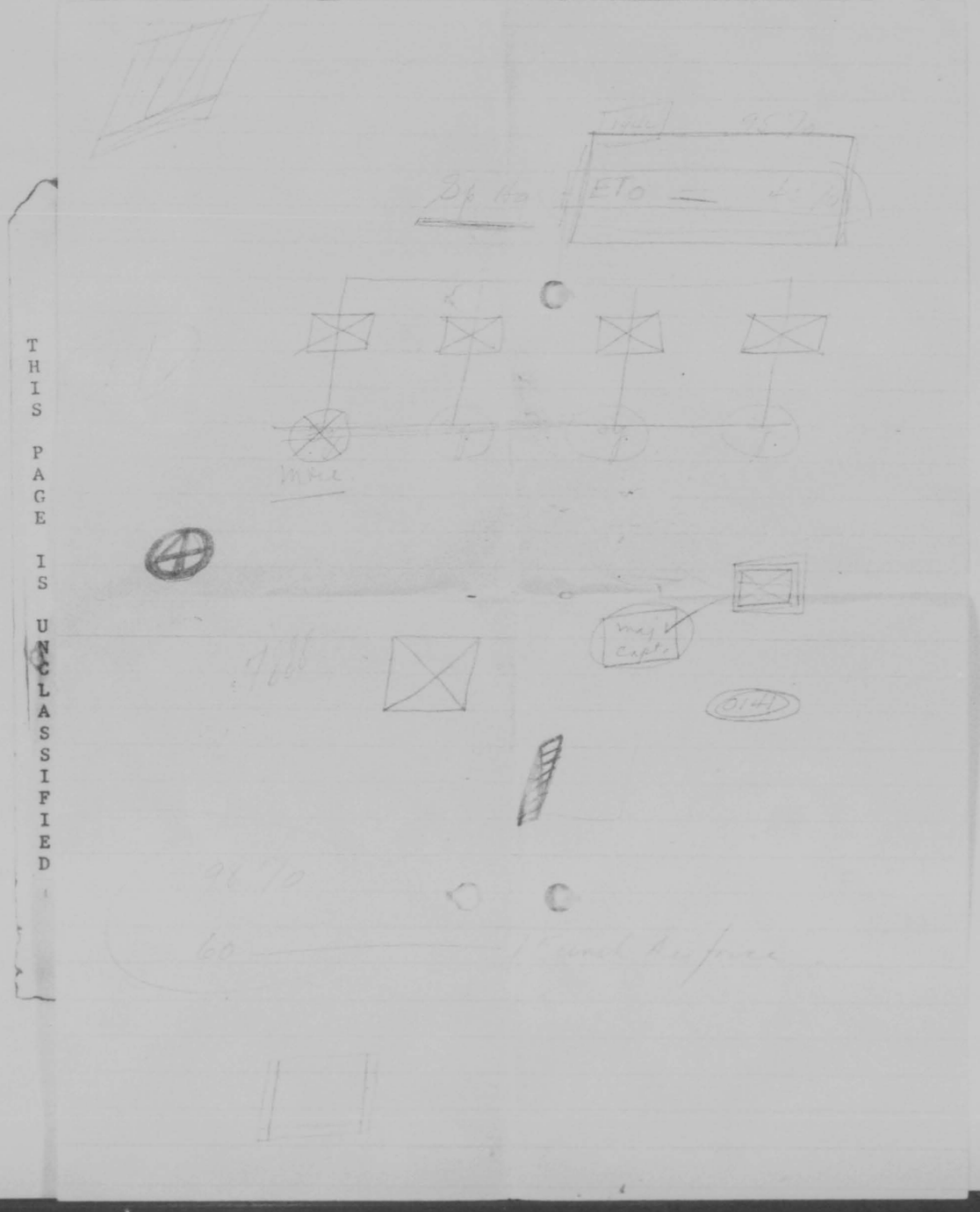


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PERSONNEL PROBLEMS

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21 May 1945

MEMORANDUM FOR CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: VHB Crew Augmentation Plan

1. Until bases within heavy bombing range of Japan are operating the VHB units deployed in the Marianas will be the only effective instrument for bombing the Japan mainland. The XXI Bomber Command has not now, and is not scheduled to have, sufficient crews to fly its airplanes 100-110 hours a month per airplane assigned, which was the rate of utilization in March and April. The projected sortie rates computed by the XXI Bomber Command show that maximum use of available aircraft could be obtained with a ratio of total crews assigned to total aircraft assigned (including U.E. and reserve) of 2:1; in order to achieve that ratio a substantial increase in the flow of crews to the XXI Bomber Command is needed.

2. Even with this augmentation, crews will be required to fly approximately 80 combat hours per month per crew assigned, in addition to training hours, for the next few months. As more crews arrive the flying time will gradually decrease and reach approximately 60 hours per month toward the end of the year. In view of the fact that each mission over Japan requires the crew to be constantly on the alert for at least 28 hours, it is believed that 80 combat hours per month per crew assigned is the maximum which can be sustained without serious impairment of efficiency. Without the desired crew augmentation, crews would have to fly more than 80 hours to permit maximum utilization of the assigned aircraft.

3. It is charged with the job of surveying the possibilities for increasing the flow of crews to the XXI Bomber Command. Informal conversations were held with various agencies of the Air Staff as well as with Civilian Training Consultants and officers of the Second Air Force in order to establish the facts on which to base suggestions for a workable crew augmentation plan.

4. The outstanding fact to emerge from this brief survey is that the present VHB Program does not provide for utilization of the Heavy Bombardment Groups brought back to this country for conversion. When a Heavy Group is returned here the Flight Echelon is broken up and the crew members are sent back into the Training Command as individuals. Most of them will remain there permanently

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unless discharged from the service. Relatively few crew members in the scarce categories will be ploughed into the Training Command pipeline for a minimum of six weeks and a maximum of twenty weeks of retraining. Then they will be sent to the Second Air Force for an additional three months of CCTS Training and at least one month of OTU Training. A minimum of seven months will thus elapse between their arrival in this country and their availability for service overseas. By that time their group identity as well as their crew identity has been lost completely. The bulk of all crews ear-marked for Flight Echelons in the "redeployed" groups will consist of Training Command graduates who have never been overseas and who do not identify themselves with the group they are to join. The only part of the group to be "redeployed" is the group name and some members of the Group Staff. The Air Echelon will be completely new, as will be most of the Ground Echelon in which a turnover of 75 to 100% is expected.

5. This policy results partly from the Training Command's desire to get rid of its trainee surplus, partly from a narrow interpretation of General Arnold's Directive that men who have not yet been overseas will be sent out in preference to returnees who have been in combat. The application of this policy has two serious consequences:

a. It prevents the increase in crew output which would result from feeding more experienced material into the training system and cutting the training time.

b. It breaks up the team spirit which has been built up within the crew, the squadron and the group, and which is an intangible asset of great value. Lack of teamwork is directly responsible for the fact that a new group is relatively inefficient in the theater during the first few months while trying to build up this teamwork.

I discussed this matter with recently returned officers of the 47th Wing (MB) who had come to Colorado Springs to plead for a change in present Redeployment Plans. They were most anxious to prevent the break-up of their groups and wanted to salvage at least thos crew members who would be eager to go on a second tour in B-29's if they could go with their old outfit.

6. The outlire of four plans for augmenting crew flow to the XXI Bomber Command is presented below. Three of these plans preserve the integrity of "redeployed" groups and will utilize the combat experience gained by MB Group overseas. Plans A and B are the most practical and could be implemented at once without dislocation of training system or the AAF Program. Plans C and D require comparatively major changes and are less desirable than A and B except in an emergency requiring prompt deployment of maximum force against Japan. All four plans are presented here to show that an increase



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in the output of VHB crews is not impossible and that there is a variety of ways in which it can be accomplished.

PLAN A

Total production of CCTS to go directly to the theater upon graduation.

That part of present CCTS production now ear-marked for flight echelons in "redeployed" groups to be sent to the XXI Bomber Command as "overages" for a three month period, after which they will join their group in the theater.

Ground echelon and Group Command and Staff will train in the United States and move out exactly as now scheduled though without flight echelon. They will thus spend two months in the theater before operating as a unit. However, a small cadre of flight crews could be returned from the Marianas before completing three months service in order to assist the Group Staff and Ground echelon to acquire experience.

In the present plan calling for the Flight echelons to move with the Ground echelons after one month of OTU Training at least four weeks would be required overseas before the Ground echelons are established, before Group Staffs have begun to function and Flight Crews have completed their shake-down missions. There would be at most one month delay in the functioning of the group in the theater as a unit while there would be a distinct gain in terms of sorties delivered against the enemy, if Plan A were substituted for the present plan.

The ground echelons would get experience in the Continental United States by maintaining B-29's for transitioning Group Staff personnel and by carrying 21st Wing DIR load to the extent of their capabilities.

Group Staffs could use the month during which they remain in the United States, after departure of the Ground echelon, for further indoctrination at the XXI Bomber Command Lead Crew School at Harroc.

The advantages of this plan are:

a. More sorties could be flown against Japan in the critical months between now and the end of the year.

b. The storage problem would be eliminated. Due to delays in the availability of bases overseas, most units of the XXI Bomber Command had to be held in this country beyond their scheduled date, clogging the training system and preventing their prompt deployment upon graduation. There is every prospect that the seam situation will be encountered by units of the XX Bomber Command. Under the pro-



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posed plan Flight Crews could be held and put to use in the Marianas until their own bases are ready to receive them without a loss of combat sorties.

c. More aircraft would become available. Augmentation crews sent to the XXI Bomber Command would not need airplanes since the ratio of crews to aircraft in the XXI Bomber Command is too low. Thus approximately three aircraft-months per crew would be saved and could be made available for training.

d. Flexibility of assignment can be provided. The "overage" crews could be returned to the AF Bomber Command whenever it becomes apparent that they could operate more effectively from another base.

e. The units would move to the theater as now scheduled without any change in deployment plans and without affecting the Troop Basis overseas or in the Z/I. Flight Crews would be simply on DS with the XXI Bomber Command and would be carried as temporary "overage".

PLAN B

All OCTS graduates to be used as replacement and augmentation crews.

Instead of diverting OCTS graduates to Flight echelons for "redeployed" groups form these Flight echelons out of returned HB Groups. If necessary filler crews can be taken from the present surplus of trained HB Crews.

Divert one OCTS to special conversion training for airplane commanders, pilots and flight engineers. These three crew members to be converted as a team in a six weeks course with a production of 80 to 100 teams per month.

Expand the present functions of the special Second Air Force Station at Pueblo to train radar operators, gunners, bombardiers in numbers corresponding to the airplane commanders - pilot - flight engineer teams. A six weeks course is deemed sufficient.

Upon completion of the six weeks conversion training in the two schools, the complete Air echelon would under-go four weeks group training at an OTU base exactly as now scheduled. If desired such training could be expanded to more than one month if Heavy Bombardment Groups are brought back in time. The present one months limit on OTU Training is due to the lack of sufficient OCTS graduates and not to lack of sufficient bases.



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OTU bases are now provided with a permanent base complement of approximately 2,000 men. If necessary the maintenance personnel could be stiffened by key personnel drawn from the theater or from VHB CCTU in exchange for experienced heavy bombardment maintenance personnel.

Flight crews would be drawn primarily from the personnel of returned HB groups selected by their group commanders on a volunteer basis. This would assure a backbone of key personnel with combat experience. Additional fillers could be provided out of the surplus of trained HBC graduates in the Second Air Force.

The main difficulty in forming VHB groups out of HB personnel is presented by radar operators and flight engineers. At present twelve H2X operators per group are available in HB groups overseas. This number could be increased by drawing on the H2X operators of several returned groups to form one redeployed group. The balance could be provided by expanding the present Second Air Force Program at Pueblo where navigators (SSN 1034) are now being converted to radar operators.

Flight engineers are the only serious problem. It is believed that crew chiefs (SSN 748) taken from the surplus of recently graduated HB crews would generally make better material for flight engineer training than returnees, since the latter are used overseas mostly as top turret gunners and have little opportunity to practice their primary specialty. Selection should be made from both sources on an individual basis. It is suggested that crew chiefs be sent to a B-29 factory school before being trained in the conversion school.

If the Training Command could be induced to increase its production of radar operators and flight engineers, the plan would be facilitated, but if necessary it could be handled by the Second Air Force without assistance from the Training Command.

The main advantages of Plan B are:

a. The integrity and team spirit of redeployed groups would be preserved, and those crew members who prefer a second tour overseas to a Training Command assignment could be given their wish while benefiting the war effort. The staff of the 47th Wing emphasizes that a large proportion of their crew would elect a second tour if they could go out with their own outfit. In view of the fact that heavy groups overseas have from 100 - 120 crews per group, a large surplus would be available from which to draw.

b. The XXI Bomber Command would be provided with a permanent instead of a temporary increase in crew strength.

c. Crews with combat experience would become effective in the theater much sooner since experience has shown that the step from a trained to an experienced crew is responsible for many delays in the theater.

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d. The deployment schedule of the XX Bomber Command would not be affected by this plan.

e. The Training Command outlet for surplus trainees would not be diminished since the personnel drawn from returned heavy groups constitute an addition to the Program.

PLAN C

Train both replacement and unit crews by converting CCTS into transition schools, and by feeding into them returned HB crews as well as the surplus of trained HB crews in this country.

This would involve major changes in the Continental Air Forces and also in the Training Command in order to produce on a large scale the source crew members (radar operators and flight engineers). This would also require stepping up the rate of returning HB groups to this country and would clog the Training Command outlet for surplus trainees. On the other hand this plan would permit the greatest increase in crew production.

PLAN D

Use all CCTS graduates as replacements and augmentation crews.

Form redeployed groups by transitioning HB crews overseas in the ETO and MTO.

This plan would involve shipping instructor personnel and B-29 aircraft with parts to Europe and setting up an OTU training system overseas similar to the Training Command set up there by the AGF. The plan would give the crews the longest time in which to convert themselves and would best preserve the team spirity developed in combat overseas. Groups might have to draw on flight crews as well as ground crew members from other groups to provide for those not eligible for the second tour.

RECOMMENDATIONS:

It is recommended that:

a. First consideration be given to Plans A and B and that the substance of these plans be communicated to General LeMay with the request that he indicate his preference;



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b. After the Twentieth Air Force has decided on one of the plans the decision be communicated at once to the Air Staff with request for immediate implementation;

c. If Plan B is chosen, AC/AS, OC&R be asked to furnish AC/AS, Training for transmission to the Second Air Force a schedule showing the return of heavy groups to this country and the redeployment of groups for the XX Bomber Command;

d. AC/AS Training request the Second Air Force to prepare a staff study based on these schedules to show the number of additional VHB crews which can be made available under this plan. It is urged that no increased commitment be given to Second Air Force until such a staff study has been completed;

e. Second Air Force be authorized at once to screen and hold the personnel of the 98th and 376th HB groups now on leave in this country. Prompt action is necessary to prevent the break-up of these groups with which the program set forth under Plan B should begin.

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b. After the Twentieth Air Force has decided on one of the plans the decision be communicated at once to the Air Staff with request for immediate implementation;

c. If Plan B is chosen, AC/AS, OC&R be asked to furnish AC/AS, Training for transmission to the Second Air Force a schedule showing the return of heavy groups to this country and the redeployment of groups for the AA Bomber Command;

d. AC/AS Training request the Second Air Force to prepare a staff study based on these schedules to show the number of additional VHB crews which can be made available under this plan. It is urged that no increased commitment be given to Second Air Force until such a staff study has been completed;

e. Second Air Force be authorized at once to screen and hold the personnel of the 98th and 376th HB groups now on leave in this country. Prompt action is necessary to prevent the break-up of these groups with which the program set forth under Plan B should begin.

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

6 October 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS SECTION, SECOND AIR FORCE

Subject: The Problem of the Radar Operator, Specifically in the B-29 Airplane.

1. In a preceding Memorandum (26 September 1944, "Notes on a Visit to Fairmont") comment was made on the possibility of improving results in radar operation by rational improvement of the conditions under which the operator works. It should not need emphasis that the importance of radar operation requires that every reasonable effort be made to increase its efficiency, Sometimes it appears that, given a certain limit of precision (for example, in scope resolution) which is built into the apparatus, it is not worthwhile to attempt "refinements" with respect to the operator. Any such view is very definitely erroneous. It seems to be based upon an imperfect understanding of the way in which "errors" compound.

2. It is important that the visual performance of the operator be as nearly excellent as possible. It is of equal importance that the conditions under which he works should be the most favorable possible for the neuromuscular coordinations involved in his tasks. The current installations which I have been able to examine violate in a rather extreme and callous way the elementary principles which should be given attention if the two closely interrelated human activities mentioned are to be carried out with reasonable efficiency. The conditions now imposed are loaded against the operator. They affect his reading of the 'scope, his manipulation of the unnecessarily numerous controls, and his critical interaction with navigator and bombadier. Unless they are improved, it is unreasonable to expect maximum realizable performance from the radar installation.

3. Points legimately made against the present installation, and which should be kept in mind with reference to possibly imminent modifications, include:

a. The radar compartment should be ventilated in such a way as to provide real movement of air.

b. The compartment is too hot. The inverters beneath the deck produce considerable heat. From the combat theater it is known that the compartment can become too hot for the proper functioning of the equipment, so that fans have been requested. The best performance from humans also needs attention.

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c. Ventilation is also desirable to reduce the odor of 100 octane gasoline.

d. The toilet is placed in the radar compartment. The odors it generates are nauseating. A means must be found to reduce this enery of efficiency, on long missions particularly. It is important for the crew as a whole as well as for the radar operator. Consultation with the Air Surgeon's Office, Hq. Second Air Force, produced the suggestion that the receptacle be well cleaned before each mission, and that it carry several inches depth of water with a covering layer of pine oil, which should act as a partial barrier to odors. I am also informed that this problem has been put to a recent meeting of Group Surgeons. Other methods of this difficulty are also being considered. This does not quite answer the question as to why the radar compartment was chosen in the first place.

e. Inadequate attention has been given to the proper illumination of the radar compartment. A general low level of illumination (without highlights) corresponding to that of the properly adjusted radar screen should be more efficient.

f. It is important that the 'scope operator in critical periods breath as high a concentration of oxygen as possible. As much as 100 per - cent at sea level atmospheric pressure, even if the compartment is pressurized--if maximum visual performance is to be obtained. This is particularly true with low rates of "gain", such as should be used for best resolution on the 'scope. (This may require some modification of the 'scope shield to admit the mask.) The eating of sugar at intervals is also recommended. Smoking cigarettes should not be permitted; it can definitely reduce vision, even at $O_2$ - equivalent 10,000 ft. altitude, through the side-tracking of the oxygen-carrying blood haemoglobin by carbon monoxide in cigarette smoke.

g. The spacial arrangement of equipment and controls, in relation to what the operator has to do, was not invented by anyone--it just happened. It is not even the same in planes which have passed through different modification centers. In any re-assignment of radar equipment to another location in the airplane, which it is understood that certain suggestions contemplate, it is highly desirable that well-known principles of task organization be given elementary attention. The functioning of the operator will be definitely made more efficient.

h. Distinctive fluorescent lighting should be installed for control dials and switches.

i. A window (with curtain) should be provided in the radar compartment, The unnecessarily crowded space resulting from the inefficient design and poor arrangement of equipment increases anyone's tendency to claustrophobic upset.

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j. The radar operator should, and could, be provided with a place to keep his log, guides, and other momentarily used accessories. He should have a map table equipped to hold papers in place, by elastic straps or some other appropriate device. Otherwise, he will have to hunt on a darkened floor for articles which movements in his dangerously cramped space have knocked into the void.

K. The obviously inefficient installation of equipment items imposes a mechanical hazard to safety. Sharp cornered brackets, edges and corners of boxes, protrude in the strangest places. It is already known that parts of the equipment break loose and thresh about on forced landings, such as ditchings. Simpler, better designed, and stronger mountings occupying less space are really required.

4. A question which immediately obtrudes concerns the initial selection of radar operators, their training, and the means employed to evaluate their relative efficiencies. So far as can be learned here, no special tests of visual capacity were involved in the initial selection of the men. It is realized that the statistical demands of a hurried program do not admit comparatively academic considerations; but this much at least is true; - the schemes of proficiency rating have been based upon performance with artificial test-objects at ground level, and were apparently derived from experience in the selection of ground-located radar operators. There is involved here a type of fallacy common to all aspects of the selection, testing program. It is significant rankings of subjects can be obtained which will reflect comparative efficiencies of men under other and quite different conditions in the air and under combat stress. Behavior at altitude is not necessarily revealed by performance in an anoxia chamber, and misleading conclusions are easily obtained when this is forgotten. A note written some time ago bears upon this, and is appended. The tests of "evaluation" procedures for radar operators, as discussed in a recent report ("Report of Aircrew Evaluation and Research Detachment", from the Office of the Air Surgeon, 19 Sept. 1944), give no sign that the importance of this general fact has been effectively realized. The tests discussed are essentially tests of accomplishment, and throw no light on the basic question of primary efficiency with reference to initial selection. Moreover, the testings which have been made throw no light whatever on the essential matter of individual interaction with other members of the flight crew. These statements are to be understood as made with recognition of the mechanically imposed conditions with regard to selection problems in a very rapidly expanding and diversifying Air Force; they are not captiously critical.

5. It is earnestly recommended that effort be made to improve the physical conditions under which the radar operator works. Improvement is easily possible. It will be repaid in navigational security, and in bombing efficiency. The principles involved are simple and largely



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obvious. It is clear that there has been no over-all control of the factors of efficient design with reference to the radar man's job. There is no good reason why such control should not be exercised in current or planned modifications of equipment and its installation.

W. J. CROZIER
Operations Analyst.

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HEADQUARTERS, TWENTIETH AIR FORCE
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FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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11 October 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS SECTION, SECOND AIR FORCE

Subject: Organization of the Radio and Radar Equipment in the B-29.

1. A general survey was conducted between 22 September and 3 October in connection with the electonic equipment presently installed in the B-29. The survey was conducted at the Radiation Laboratories of Massachusetts Institute of Technology and the Aircraft Radio Laboratories at Wright Field. During the course of the survey a detailed inspection was made of the electronic installation in the B-29 and it was clearly evident to all those present that a more efficient organization of the radio and radar equipment is necessary if a higher degree of overall operating efficiency is to be realized.

2. Since the combat effectiveness of the B-29 depends largely upon the reliable operation of the radio and radar equipment and the efficient functioning of the operating personnel, it is felt that any steps taken in this direction will be definitely worthwhile.

3. The present radio communications installation consists mainly of equipment previously assigned for aircraft containing only a portion of the equipment installed in the B-29. It is therefore evident that an over-crowded and inefficient condition will exist unless additional space is provided for the additional equipment or the equipment is designed and installed in accordance with a definite predetermined plan. Since the space available for the radio operator and the radio equipment in the B-29 is but slightly larger than the space available in other aircraft which carry much less equipment, it is obvious that a planned design on installation procedure must be followed to release the present over-crowded and inefficient condition.

4. The construction of a centralized radio communications system designed to perform all the required functions and powered by a central power system would produce the following advantages:

a. A reduction in personnel errors under combat conditions would be facilitated by the standardization of equipment locator and controls, and the simplification of the operating procedure.

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b. A simplified training program would be possible due to the reduction in the number of operational functions now performed by the operator.

c. A reduction in equipment weight would be possible by the elimination of numerous inter-connecting cables, plugs, mounting brackets, and individual dynamotor power supplies.

d. An increase in equipment protection would be possible since the centralized equipment could be protected by armor plate.

e. Production would be materially increased due to the decrease in the number of cables, plugs, individual mountings, individual dynamotor power supplies, and equipment locations.

f. Flexibility would be increased by the use of standard sized equipment and mounting assemblies.

5. The present inefficient conditions which exist in the radar operator's compartment can be overcome by a definite knowledge of what radar functions are required to accomplish the combat purpose of the aircraft. Equipment, without duplication of functions, could then be designed and constructed in a form relative to what the radar operator has to do and electrical efficiency. Equipment designed along these lines would produce greater operator efficiency and speed and materially reduce weight and personnel hazards now existent. (See memorandum, "The Problem of the Radar Operator," by Dr. W. J. Crozier.)

6. It is therefore recommended that immediate steps be taken to formulate a plan which may be followed in the design and construction of future airborne radio and radar equipment. It is further recommended that immediate steps be taken to determine what changes or modifications are possible, at the present time, to increase the overall efficiency of the radio and radar requirements of the B-29.

AUBERT E. BENNETT
Operations Analyst

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11 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Visual Effects of Ultra Violet Light

In my Laboratory at Cambridge, work is currently in progress by my Research Assistant, Dr. E. Wolf, supported by American Optical Company, to determine whether exposure to ultra violet light affects visual performance. This question must be considered apart from the problem of corneal injury. No functional tests for effects upon visual capacity have previously been made. The results thus far show definitely that exposure of the eyes to moderately high intensities of the usually encountered u.v. radiation do in fact have pronounced effects in decreasing visual resolution, which take a comparatively long time to disappear. There are two possibly significant points: Ultra violet sources are used to induce fluorescence of dial markings on cockpit instruments; they are also used to make luminous the fluorescent clothing of men on aircraft carrier decks. This note is recorded merely for current information.

W. J. CROZIER
Operations Analyst

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FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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25 November 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Review of Radar-bombing Program.

1. In the radar-bombing operations of XX Bomber Command to date, failure to achieve good radar-DR navigation is believed responsible for most of the gross errors, and gross errors are largely destroying the effectiveness of this type of operation. This problem is difficult to cope with but its solution is believed prerequisite for successful radar-bombing operations. This problem will be rendered more acute, rather than otherwise when the high-resolution equipment AN/MPQ-7 is introduced. High level review of this question and appropriate action seem essential. (See separate memorandum, dated 25 November 1944).

2. Accuracy of APQ-13, when the present direct bombing technique is employed, is not sufficient for effective bombing of our typical strategic targets, that is, factories or even fairly large factory regions situated in urban areas. Even after gross errors resulting from navigational errors have been eliminated, errors on "good" runs will be 1 or 2 miles, -- of the order of the radius of the urban area.

3. An offset method which is simple for the navigator and convenient to handle from the standpoint of the operational laying-on of missions is urgently required. If it can be found it will make possible the reduction of the error of 1 to 2 miles expected for direct bombing to about 700 yards. This is good enough for effective bombing of typical targets and will also provide a valuable aid in visual sighting. Unless such a method can be made available present equipment can be expected only to be effective in the bombing of urban areas generally (and this only on the assumption that the gross navigational errors discussed in paragraph 1 can be brought under control).

4. Bombsight technique has overcome many of the difficulties with the offset methods which have previously been tried. This fact, in view of the inherent limitations of direct bombing above indicated, should provide the basis for a review of policy on offset methods. Possible offset procedures should be reconsidered in the modification most suitable for bombsight technique in the endeavor to find a procedure which is simple and operationally feasible.

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5. A new simplified offset bombing procedure has been worked out in detail which not only is flexible operationally, giving entire freedom of direction of approach, but also requires no computations in advance of the mission other than the location of suitable reference points and the determination of their range and bearing from the target. Any of these can be used as desired, or the bombing can be by the direct procedure, without modifying the planning of the mission. Early test of this method is urged in comparison with any others which appear possible. If the essential requirements are found to be met, training in the procedures involved should be incorporated in the training program as soon as possible. (The offset bombing problem and the new proposed method discussed in detail in a separate report, dated 18 November 1944).

6. Separate specially trained radar bombing accuracy groups are believed an urgent requirement for each Bomber Command engaged in this type of operation. A straightforward procedure is now available for analysis of scope photograph sequences taken during the bombing run to calculate the position of bombfall. Definite plans can therefore be made and the required personnel assigned and trained for this work. It is urged that such a program be laid on at a high level of priority. It is believed that in blind bombing, as well as in the sciences, progress must depend on accurate measurement of results.

W. N. TUTTLE
Operations Analyst

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7 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Use of Bombsight with AN/APQ-7 Equipment.

1. Standard APQ-7 Equipment does not lend itself readily to operation with the bombsight, so that it gives no aid to the bombardier in making visual sighting through broken cloud. Modifications of the equipment to overcome this limitation have recently been proposed as follows:

a. An auxiliary sighting angle switch setting into the instrument the proper slant range for certain preselected sighting angles. This has been proposed as an interim measure which could be made available in a few weeks.

b. A bombsight attachment known as "Nosmo" giving a meter indication to the bombardier and permitting continuous tracking of the target response on the radar equipment. This equipment is proposed as an ultimate replacement for the switch described above.

2. Either of the above arrangements should be satisfactory whenever the aiming point can be identified in the response of the target area, and the greater resolution of the APQ-7 equipment should make this possible much more frequently than with APQ-13. Essentially the APQ-7 presentation provides a larger scale map on which to pick out the target, but just as with APQ-13 it is believed that nearby points will frequently be identifiable with less chance of error than the target itself. Suitable points should be easier to find than with APQ-13, and such things as bridges, parks, etc., should be suitable. It seems unreasonable to assume that offset bombing technique will not prove highly desirable even with high resolution equipment such as APQ-7.

3. The urgency of not delaying the present program for the sighting angle switch referred to in paragraph 1, a., is fully realized. There seems to be some possibility, however, that this attachment can be made equally well in a form which would permit the use of offset procedure. The offset system described in the November 18 Memorandum, would require that a dial calibrated in either slant range, ground range or "B" should be available in addition to the sighting angle switch. Radiation Laboratory is investigating whether such an additional control is feasible and whether appreciable delay in the program would be involved.

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4. It is possible that if offset methods with the modified sighting angle switch prove feasible and reasonably simple, this arrangement may prove preferable to "Nosmo", as the latter does not appear adaptable to true offset bombing. It seems most desirable not to adopt a procedure which closes the door to offset methods before it has been demonstrated that they will not be required in the use of APQ-7 equipment.

W. N. TUTTLE,
Operations Analyst

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FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

2 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Problems in Radar Bombing in Relation to Contemplated 315th Wing Operations

I. Introduction

1. The new APQ-7 equipment with which 315th Wing is to be equipped has considerably greater resolution than earlier radar bombing equipment such as APS-15 or APQ-13. Moreover improved direct bombing procedures have been developed so that high accuracy has been obtained in the practice bombing of point targets. In this memorandum the endeavor will be made to assess the importance of other factors, largely operational, on the success of blind-bombing missions of the type contemplated, and to review the training program in the light of these factors.

2. In order to bomb successfully, an attacking unit must first navigate to the target area and then make a normal bombing run, that is a run without gross error. Also the bombsight and the bombing procedure must be such that the Cep of the normal bombing is small enough in relation to the size of the pattern and the size of the target for the operation to be profitable. Accordingly factors preventing normal bombing runs, that is, factors preventing bombing at all or causing gross errors will first be considered, and the bombing error then discussed in relation to the type of target and the particular procedure employed.

II. Causes of Failures and Gross Errors in Radar Bombing

1. Factors which prevent normal bombing operations from being performed are believed of even greater importance in the reduction of the operational effectiveness of blind bombing missions than is the limitation of accuracy of the equipment. A major effort must be made to bring and keep these factors under control. On the other hand it should ultimately be possible to do better in this regard than in the elimination of similar factors from visual bombing operations, where normal aimings, even in good weather can seldom be performed in more than 50 per cent of the attacks, and for some types of targets in only 25 per cent of the attacks. This factor offers the possibility of ultimately achieving

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greater success in radar than in visual bombing.

2. Principal causes of failure to carry through a normal radar sighting are believed to be the following:

a. Equipment Failures - These result both from defects of design and manufacture and from inadequate maintenance. As these are obvious when they occur, appropriate corrective measures can be taken both in the theaters and in the training program in this country. Considerable improvement in serviceability has in fact resulted over the past year with APS-15 and APQ-13 equipment, a figure of 80% having been achieved by XX Bomber Command. It should be possible to improve on this figure, and in any event it should be made certain that adequate provision for maintenance training is made in the 315th Wing program in this country so that past unfortunate experiences will not be repeated after movement of the unit overseas. It is understood that particular attention must be paid to certain maintenance problems to insure satisfactory operation of APQ-7 equipment at the higher operational altitudes contemplated for 315th Wing.

(1) The trained maintenance officers intended for the unit, as suggested earlier, should be transferred to it as long prior to departure as possible, preferably at the beginning of the Second Air Force training program. Sufficient equipment should be provided, also, so that maintenance training can continue while the Wing is with Second Air Force.

b. Gross Personnel Failures on the Mission - These result not only from deficiencies in unit training in the details of special equipment, but also from insufficient practice of the crew drills involved in the various operations to be performed. These failures, like equipment failures, are usually obvious, and as the organization and discipline of a unit improves in the field, are usually brought under control. It seems obvious, however, that it is wasteful and delays rather than advances the program for such basis training to be done under great difficulty abroad rather than in this country. Adequate training time at Second Air Force seems highly desirable in view of this factor alone.

c. Failures in Navigation to the Target Area - These occur much more frequently on radar bombing missions than is generally supposed. They result not only in failures to reach the target area and in lost aircraft through running out of fuel, but also in many bombing failures resulting from an approach to the target being in a different direction from that intended and consequent failure to identify the target in the response pattern soon enough for normal bombing procedure. As pointed out in an earlier Operations Analysis Division Memorandum, dated 25 November, past failures of this kind seem largely due to failure to

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achieve good teamwork between the navigator and the radar operator. The crew drill should be so organized that real DR navigation is practiced by the navigator, based on radar information supplied by the radar operator. Navigation is an art and the necessary skill cannot be obtained without considerable practice. This should involve the whole crew and should be on simulated operational missions. It is felt most strongly that success in radar bombing on operational missions cannot be achieved unless particular emphasis is placed on DR navigational procedure involving the use of radar data.

d. Failures in Target Approach After the Turn at the I. P. - Particular attention to this phase of the procedure is needed with APQ-7 equipment both because of the limited field of view and because the higher resolution makes it important to reduce the area of the response which is studied in detail in the attempt to determine the aiming point. Unless this approach can be made accurately and the radar operator knows just where to look for expected landmarks, it is believed that many missions will fail through inability of the radar operator to pick up the required responses soon enough. Second runs over the target area are almost never successful and can hardly be provided for, from the fuel standpoint without seriously reducing the bomb load.

(1) It is believed that the offset procedure discussed below in relation to the bombing operation should be applied also to precision approach and should greatly increase the number of attacks on which the aiming point can be picked up successfully. Every effort should be made to have offset approach procedure incorporated in the Second Air Force training program for the 315th Wing, and Air Forces Board investigation of the techniques involved, as well as of the offset bombing procedure discussed below, should be initiated on the highest priority. A new simplified offset method in which the same procedure can be used either for approach or for bombing or both was described in detail in an Operations Analysis Division Memorandum dated 18 November 1944.

e. Gross Errors in Bombing - Even when a proper approach is made it should be expected that there will be many cases where the wrong response will be picked up or the pattern wrongly interpreted or a proper run not made because the operator does not have time to perform the required operations. These are not the gross personnel errors discussed in paragraph 2 b, but result largely from the inherent difficulty of the job which has to be performed. Improved reconnaissance and briefing should help greatly in reducing gross bombing errors, but even more important is believed to be the adoption of as simple a bombing procedure as possible so that the radar operator will have ample time to study the response of the target area and perform the operations required. It is felt very strongly that the bombing operation should not be complicated by procedures directed to the elimination of small errors, say of the order of 500 feet or less, although such refinements of technique must obviously

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be employed in experimental test bombing where it is desired to determine the essential limitations of equipment and procedures. In particular it is felt that every effort should be made to work out operational bombing procedures which do not involve wind or drift determinations during the bombing run. Wind determination by radar methods are of the greatest importance, but these should be made as far as possible prior to the turn at the I.P. It should be borne in mind that rapid changes in wind do not occur at high altitudes.

III. Sources of Error in Normal Radar Bombing Runs.

1. The factors which have been discussed in the preceding section are those which prevent a normal bombing run to be carried out. It is proposed here to point out sources of error other than the inherent limitations of the equipment which affect the accuracy which is obtainable in attacks on operational targets.

2. The assumption seems fairly general that the principal factors governing the effectiveness of radar bombing are the inherent accuracy of the equipment, as determined in the bombing of point targets, and the resolution obtained in the radar response pattern. Since APQ-7 equipment has high inherent accuracy and considerably greater resolution than APQ-13, this view would lead to the expectation of far better results in the contemplated operations of 315th Wing than would be possible with APQ-13 equipment.

3. It is believed, however, that only a very small percentage of operational targets will give sharp responses on which a direct aiming can be made, permitting this increase in accuracy to be obtained. In the great majority of cases the position of the aiming point must be estimated within a response pattern covering a fairly large area and the error of this judgment on the part of the operator is likely to be many times the error in the actual sighting operation.

4. For discussion of the relative importance of aiming errors and identification errors, precision targets can be put in three groups:

a. Small Targets Giving an Identifiable Response - It should be possible to attack these with the full accuracy of which the equipment is capable. This should be about 600 or 700 yards with any one of several bombing methods with APS-15 or APQ-13 equipment, and perhaps half this figure or even better with newer equipment using synchronized tracking or with APQ-7. It cannot be emphasized too strongly, however, that very few of our targets are in this category. Even the high resolution of APQ-7 can not be relied on to make visible factories located within the limits of urban areas. Direct precision aimings will be possible on bridges, aerodromes, railway junctions, and marshalling yards, and in some cases on docks and harbor installations, but that is about all. In addition isolated factories away from towns should give a good response, but are very difficult to pick up and identify unless a precision approach procedure, as discussed in the preceding section, is made available.



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b. Targets Framed by a Sharp Response Pattern - as on a peninsula or within a loop of a river showing up in the response. In cases of this kind, if the briefing has been properly done, it should be possible to estimate the location of the aiming withing perhaps 500 yards. Even in these cases it is believed, therefore, that the "identification error" would be appreciably greater than the aiming error of the equipment. As the total error is the root mean square of the identification and aiming errors, the final result on targets of this kind would not be appreciably affected by the greater accuracy in aiming of APQ-7.

c. Targets in Urban Areas - Targets in coastal cities would belong in the preceding group in some cases, but unless the aiming point is near an identifiable portion of the land-water boundary, identification errors are considerably increased over the value given. Identification errors seem unavoidably large when the position of the aiming point must be estimated within the response pattern of inland towns. It is most difficult to reduce this error in these cases to less than a mile if a direct bombing technique is employed. A suitable offset method should greatly reduce this error as one or more reference points are available within 4 or 5 miles of the aiming point for the majority of targets of interest. The large error in direct bombing arises partly from the large variability in the shape of the response pattern with volume control setting, direction of approach, scanner adjustment, etc., and partly from the error in locating the aiming point within the pattern. Since all this is quite apart from actual mistakes in interpretation of the response pattern, included in the discussion of gross errors in the preceding section, improved reconnaissance and briefing will not solve the problem. This is illustrated by experience of the British, who, by particular attention to training, reconnaissance, and briefing, reduced their operational error from 3 miles in 1943 to 1.1 miles in August 1944, the targets being in German cities.

(1) The bearing of the higher resolution of APQ-7 on the problem of the reduction of the identification error should be considered, as it has frequently been assumed that only the aiming error would remain. With APQ-7 the response pattern of the town will still vary in shape with the direction of approach and with the volume control setting. The principal difference is that smaller rivers and inlets will be visible, so more targets will be in the preceding category, and more landmarks will be visible. In addition to bridges, airfields, railway lines and junctions, previously mentioned as suitable for precision direct attack, parks of moderate size within built up areas should stand out clearly. In short, to the extent that these additional landmarks can be used to help in the estimation of the location of the aiming point, the identification error will be reduced. If the aiming point is estimated by the boundaries of the urban area there is no reason to expect an increase in accuracy over that obtainable with earlier equipment. In general, however, use of nearby landmarks





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rather than poorly defined urban boundaries in estimating the target location should result in bombing errors with APQ-7 being of the order of 1000 yards rather than the value of a mile or more in the case of APQ-13.

d. Even though errors on targets in the first two categories given are 300 and 500 yards, and though attacks on these targets should be successful, these targets, as above indicated, are expected to be only a small proportion of the total. On the great majority of targets the 1,000 yard error is the minimum that can be expected, even with proper operation of the equipment in direct bombing procedure, because of the residual identification error. This error is still too large for successful bombing of factories or precision targets generally. It should be adequate, however, for incendiary attacks on particular portions of urban areas.

e. We are forced to the conclusion that even after proper attention to briefing and approach to permit a maximum number of direct aimings, offset bombing procedure is still required to provide a weapon generally useful in precision attacks on our strategic targets. Every effort should be made to give thorough crew drill and simulated operational practice on a suitable offset method. (A proposed method is discussed in detail in an earlier Operations Analysis Division Memorandum dated 18 November 1944.)

IV. Recommendations

1. If in any way possible sufficient time should be allowed in this country for sufficient maintenance training and training in basic crew drills and on special equipment so that excessive maintenance failures and gross personnel failures will not occur.

2. Provision should be made for increased crew training in radar - DR navigational teamwork, particularly on simulated operational missions.

3. Air Forces Board should be directed on high priority to investigate offset approach and bombing procedures.

4. A suitable offset approach procedure should be incorporated into Second Air Force training of 315th Wing.

5. A new offset bombing procedure should be incorporated, likewise, in the Second Air Force training program for 315th Wing.

W. N. TUTTLE,
Operations Analyst.

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.





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Equipment and Tests for Offset Bombing.

OC&R Division
THRU: Air Communications Officer. 4 Jan 45
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Chief of Staff, Twentieth Air Force.

1. Evidence is increasing that only a very small proportion of the targets of interest to Twentieth Air Force will give an identifiable sharp radar response. In other cases the location of the aiming point will have to be estimated within the response pattern of the target area in relation to identifiable landmarks which may be 1 or 2 miles distant in the case of APQ-7 equipment, and possibly 4 or 5 miles distant with APQ-13.

2. This estimation or identification error is believed to be inherently large, even when the reconnaissance and briefing have been good and the bombing run properly made. Errors from this source are expected to be 1000 yards or more with APQ-7 equipment and between a mile and a mile and a half for APQ-13 equipment. These errors are in addition to the normal aiming errors of the equipment on point targets.

3. These errors are too large to permit profitable radar bombing missions against the targets to be attacked by Twentieth Air Force. It is estimated that operations will begin to be profitable if the probable error of the bombing can be reduced below 2000 feet, and will be highly effective if the error can be reduced to 1000 feet.

4. It is believed that offset approach and bombing procedure offers the only possibility of achieving the required accuracy with either APQ-13, or APQ-7 equipment. A method recently proposed appears to overcome several of the difficulties which have been encountered with previous offset methods and it is hoped that it will be simple enough to be taught readily to operational crews. This method is discussed in an attached Memorandum, dated 18 November 1944, "Operational Difficulties in Offset Radar Bombing and a Suggested Simplified Method Based on the E-6B Computer".

5. It is requested that Air Forces Board investigate this method immediately in experimental flights, initially with APS-15 or APQ-13 equipment, and later with APQ-7 as soon as the required continuously variable sighting angle control can be made available in the latter equipment in place of the fixed position control now contemplated. It is urgent that a preliminary report be submitted on the basis of tests on APQ-13 equipment to serve as a basis for planning.

6. It is desired that all ships for 315th Wing be equipped with a continuously variable controls to permit offset bombing. It is requested that production schedules on the fixed position sighting angle switches be investigated so that the change over to the continuously variable controls can be made as early as possible.

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Equipment and Tests for Offset Bombing Cont'd

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7. A modified design of Nosmo equipment for APQ-13 to permit setting of ground ranges for offset bombing is under development at Radiation Laboratory. It is desirable that tests at Air Forces Board requested in paragraph 5 include tests with this modified Nosmo equipment.

LAURIS NORSTAD
Brigadier General
Chief of Staff

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C O N F I D E N T I A L

OPERATIONS ANALYSIS REPORT

Issuing Unit: Hqrs, Twentieth Air Force,
Office of the Commanding General.

Subject: OPERATIONAL DIFFICULTIES IN OFFSET RADAR BOMBING AND A SUGGESTED SIMPLIFIED METHOD BASED ON THE E-6B COMPUTER

Date: 18 November 1944

Identification: Report dated 18 November 1944

Washington Identification: Report No. OAO-67
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Note: Operations Analysis Sections (designated in some theaters as Operational Research Sections) have been established in a number of Air Force Commands pursuant to a memorandum from CG AAF to All Air Force Commanders, dated 24 October 1942, approving this activity.

This is a report of one such section. Information as to Operations Analysis Sections and reports can be obtained from Operations Analysis Division, Management Control, Headquarters, Army Air Forces, Washington, D.C.

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C O N F I D E N T I A L

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL

Washington 25, D. C.

18 November 1944.

Operational Difficulties in Offset Radar Bombing and a Suggested Simplified Method Based on The E-6B Computer

## I. INTRODUCTION

The notion of using in the bombing process an easily identifiable reference point in the target area rather than the aiming point itself is very alluring for many reasons, such as smoke obscuration of visual targets or lack of suitable response in the immediate target area in the case of bombing by radar. Several different procedures have been proposed for offset or reference point bombing and tried operationally but results have not generally been satisfactory. The proposed methods which are simple have so far either not been operationally feasible or have not been sufficiently accurate, and the methods which are carefully worked out to give the required accuracy have involved complicated stop-watch procedures, etc., which cannot be performed with sufficient reliability by personnel now available, under the stress of a combat mission. Moreover, elaborate pre-flight computations have been involved in some cases which complicate to a considerable extent the preparatory work for a mission and the briefing of the crews.

As a result of experience with existing methods, offset bombing, at the present writing, is not being used in operations of the Twentieth Air Force and is only referred to briefly in the training courses for radar operators and navigators. Present radar bombing missions of the Twentieth Air Force are based on the ability of the radar operator to locate the aiming point by its supposed location within the response pattern of the target area. Except in the relatively few cases where the target gives an easily identifiable sharp response, bombing accuracy will be severely limited by the inherent inaccuracies of such a judgment on the part of the radar operator. This is true even with the new bombsight technique of radar bombing, which permits the release point to be determined at the time when the best definition is obtained in the target response.

This present policy of using only direct bombing procedures in radar bombing is believed fully justified at the present time, in spite of the fact that is severely limits the number of targets for which there is any possibility of successful radar attack. Operational experience has amply demonstrated that the ineffectiveness of past radar bombing missions has resulted more from the large proportion of gross errors than from failure to achieve maximum accuracy in the sightings. The failures have been largely the result of such things as bad radar navigation or inability to pick up the target response and make a normal run. Consequently anything



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which can be done to give the radar operator a straightforward procedure which can be performed with a high degree of reliability should greatly increase the operational effectiveness of radar bombing.

On the other hand, although improved radar navigation and simplified radar operator technique should make possible the successful bombing of towns, operational experience both by the British and by the Eighth Air Force has shown pretty conclusively that particular target areas within towns or in their outskirts cannot be bombed successfully by the direct bombing technique, at least with medium-resolution equipment such as AN/APS-15 or AN/APQ-13. With this equipment, it is a good rule that the best possible accuracy in the direct bombing of targets that give a small sharp response is about 500-600 yards, but bombing of targets in urban areas is subject to an error about equal to the radius of the town. Errors in normal "good" runs with AN/APS-15 or AN/APQ-13 equipment on targets in or adjacent to cities, therefore, will be between one and three miles, which is not close enough for effective attack on particular factories or even fairly large factory areas. The most that can be expected of the direct-bombing technique with this equipment is that on the average, after elimination of gross errors, a reasonable fraction, say from a third to a half, of the bombs will fall within the limits of the town itself. In other words, present training plans should make this equipment into an effective "area bombing" weapon, in the sense given, but some new approach is necessary before it can become successful in attacking our typical strategic targets.

During the next year there will be large numbers of AN/APS-15 and AN/APQ-13 sets in operation in several different theaters. It would pay enormous dividends in increased effectiveness of operations if a method could be developed for using this equipment which would permit the error in the bombing of urban targets to be reduced to a value comparable with that obtainable on point targets, say below 800 yards, and which at the same time would be simple and straightforward in operation. While current operations on suitable targets are proceeding on the basis of the direct-bombing technique, every effort should be made to develop a reference point method free of the limitations of those previously tried, and to incorporate this new procedure in the basic training of radar operators as soon as it can be thoroughly tested. In the sections following the limitations of some previously proposed methods of offset bombing will be gone into more specifically and a possible new approach to the problem, based on the use of the E-6B Computer, discussed in some detail.

## II. OPERATIONAL DIFFICULTIES WITH OFFSET METHODS

After considerable difficulty had been experienced from smoke obscuration in the target area, a grid method of visual offset bombing was worked out by Eighth Air Force permitting the aiming to be at a reference point a mile or so in front of the target. The procedure was later modified, the final system being based on the "units of tangency" differential between the target and the reference point along a line parallel to the direction of attack. After the bombsight was synchronized on the reference point it



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was set back a number of units on the bombsight tangent scale determined from a transparent grid attached to a map of the target area by a pin through the aiming point. The grid is rotatable so that it can be aligned with the direction of attack finally arrived at. This system is most ingenious and reasonably simple but suffers from the inherent limitation that no clear cut procedure is available for making the track of the aircraft pass through the aiming point. It is not sufficient to turn onto a predetermined heading after arriving at the I.P., as due to errors in flying this will result in the aircraft being on a track parallel to that intended and displaced laterally by an amount which may be large compared with the usual bombing errors. Stated another way, the aircraft may fail by a considerable angular error to turn at the I.P. onto the track which passes through the aiming point, and this azimuthal or deflection error may be very much greater than the error in range which the grid system is designed to overcome.

It was assumed for a while that if a direction of attack were chosen for which the reference point and the target would be in line, this difficulty would be avoided, but in this case, also, the pilot is required to turn onto a line fixed in space, and no indication is given to him when this line is reached. The best procedure proposed is a carefully calculated turn at a well marked I.P., but this is far from satisfactory. Clearly what is required when a reference point is used is a method which will provide corrections in heading as well as in range during the final bombing run, just as does the normal procedure when the target is bombed directly.

A subsequent proposal at Eighth Air Force, designed to overcome these limitations and the necessity of working with awkward physical equipment such as a mounted chart and grid, was to compute, at certain preselected ranges from the reference point, the target bearing and range as functions of the reference point bearing. This would overcome the main objection to the grid system, as it would provide immediate corrections to the track of the aircraft, making it pass through the target. The objections to it are that the preliminary computations, which are valid only for a particular target, are extensive and laborious and the laying on of a mission becomes complicated and inflexible. This is true even when only a single reference point is employed, and it is most desirable that several alternatives should be provided. Also the pre-selected distances from the reference point used will correspond to different distances from the target, depending on the direction of attack, so that preselected bombsight check points cannot be used. This complicates the drill between radar operator and bombardier in addition to requiring the use of fairly complicated tables in the first place. It is believed that any use of tables should be reduced to a minimum if an undue proportion of gross errors on the part of radar operators is to be avoided.

More recently a "Final Course Correction" method of offset bombing has been worked out in connection with the Second Air Force training program. A calculated turn is made at the I.P. designed to take the aircraft onto a course in line with the reference point and target. At a predetermined point 10 or 15 miles from the reference point the bearing of the re-

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ference point is compared with the briefed course, i.e., with the bearing of the line joining the target and reference point, and a turn made to make the course pass through the target. The required change in course can be simply determined for various bearings, the relation involving only the deviation from the briefed course and the known distance to the R.P. and from the R.P. to the target. Either a tabulation can be made in advance or a paper scale drawn up and attached to the instrument, so that the required correction can easily be made. A stopwatch procedure was originally involved in this method to allow for the difference in range between target and reference point, but the bombsight technique which has been adopted recently makes this no longer necessary. Reference point ranges for the desired bombsight check points can be computed fairly easily by a chart or tabular method on the flight in to the target as soon as the bombing altitude has been determined. The bombsight is clutched in and corrected at one or more check points and automatically releases the bombs when the correct distance from the target is reached.

Initial operational experience with this "Final Course Correction" method should not be considered representative of its capabilities, and the complications of pre-mission computations, stop-watch procedures, etc., which are no longer required, and the bad results obtained in early missions by untrained crews have resulted in what is felt to be unwarranted prejudice against it. Any of the several suggested bombsight adaptations of this method might prove entirely satisfactory if training in the procedures involved can be made sufficiently thorough.

At the same time the method has certain inherent limitations, even when employed with the bombsight. It is believed that the bombsight procedure justifies a reconsideration of offset bombing generally and that this and other proposed methods should be reassessed in relation to it. Use of the bombsight chiefly affects the determination of release time and although in this case use of the stopwatch procedure with its advance computations is obviated, the difficulty in getting on the correct course initially and in avoiding a fairly large turn just before the bomb run still persists. A method giving greater tolerance in the direction of approach would have many advantages, particularly if a straight course from the I.P. to the target could be obtained. A further desirable characteristic in any new method would be the possibility of making any small corrections in course nearer the target so as to reduce the deflection error. In the Final Course Correction method, if the turn is made 10 or 15 miles back from the target, as is required, and an error of 2 degrees is made in the final track, a deflection error of 1/3 or 1/2 mile, respectively, will result in the position of impact of the bomb.

## III. DESCRIPTION OF OFFSET BOMBING METHOD USING THE B-6D BOMBSIGHT

The method of offset bombing described below is proposed in an effort to overcome some of the difficulties just considered and to provide a method especially suitable for [illegible] method of release. It has been endeavored also to make the offset bombing procedure as close to that of





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direct bombing as possible in order that a simple crew drill can be adopted which can be used in either case. Finally, pre-mission work and computations have been avoided entirely except for the selection of suitable reference points and the determination of their distance and bearing from the target.

The method is based on using the E-6B Computer to give directly the range and bearing of the reference point or "R.P." from the aircraft, given the range and bearing of the target from the aircraft and from the reference point. Any method of bombing requires a procedure for getting on a course passing through the target and a procedure for determining the release point, and the solution to the given problem will provide directly both course and range data at as many points as it can be obtained. As the method is actually used, pre-selected bombsight check points are employed, the same for all targets, and the corresponding ranges of the R.P. are determined from the computer as soon as the aircraft has settled approximately on its final run. No restriction is placed on the direction of the run except that a suitable reference point should be within range.

In using the computer, an answer is sought to the question, "Assuming the present course passes over the target, what will be the range and bearing of the R.P. when the aircraft is exactly X miles, corresponding to a preselected check point, from the target?" When this problem is solved the range of the R.P. is set on the range circle of the radar equipment and the bearing of the R.P. observed when its response intersects the circle. The bearing is compared with the calculated value and if greater the course of the aircraft is increased by the difference. Meanwhile arrival at the check point has been announced to the bombardier who has clutched-in or corrected his sight accordingly.

The problem to be solved on the E-6B Computer is the exact analog of that solved by the navigator when the true air speed, heading, and wind are known and it is desired to determine course and ground speed. Target range and course being flown correspond to true air speed and heading, R.P. range and bearing correspond to ground speed and course, and the bearing and distance of the reference from the target correspond to the wind direction and speed. In one case the triangle is a vector diagram of velocities and in the other case a simple diagram of ground distances. It is believed that the ground triangle is even easier to visualize than the usual wind triangle, and in any event the steps involved are already familiar to all having navigator training.

The triangle can be solved equally well with either long side along the center line of the computer, but for several reasons it is preferable to take the range to the target along the center line, placing the target at the center mark of the computer face. The velocity scale on the slide is divided by 10 to read nautical miles instead of knots, the side reading from 30 to 300 knots or 3 to 30 miles being generally employed.

The first step is to mark on the computer face the position of the reference point. This is done by setting the angular scale at the bearing



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of the reference point from the target and making a mark on the center line above the target, that is, between the center mark and the index, at a distance from the center corresponding to the distance of the reference point from the target. This corresponds to marking the wind vector in DR navigation, but the direction of drawing the line is opposite, since wind directions are given as the bearing of the point from which the wind comes.

Next the angular scale is turned until the course being flown comes under the index and the slide moved until the target range of the next check point comes under the grommet. The range of the R.P. can then be read under the corresponding pencil mark and the bearing of the R.P. obtained by adding the angular reading on the slide to the course being flown, if the R.P. is to the right of the target, or subtracting if to the left.

The required correction to the course is given very closely by the difference between the observed and predicted bearings of the reference point, and this makes for a very simple operational procedure, as indicated above. The process is also quite sufficiently accurate. The exact course to the target, however, can also be obtained from the computer by rotating the angular scale, at the same time moving the slide to keep the R.P. pencil mark on the range which was set in for the R.P., until the sum of the course angle plus the slide angle is equal to the observed bearing of the R.P. This can be done quite readily but seems an unnecessary complication of procedure. The simpler method proposed of merely noting the difference between the observed and predicted bearings enables the course correction to be made immediately as soon as the check point is reached.

The computer solves a plane triangle, the three vertices being the target, the R.P., and the point on the ground directly under the aircraft. Consequently ground ranges rather than slant ranges must be employed in using the computer. This introduces only one additional step, rather than two, because the ranges of the various desired bombsight check points at different altitudes are determined in advance and ground ranges can just as well be tabulated as slant ranges. The R.P. ranges found from the computer, however, must be converted to slant ranges before being set into the radar equipment.

As an example of the operational procedure let us suppose that the aircraft has turned onto a course of 276 degrees which is the approximate course to the target, and that a point 20 miles from the target is to be the first check point. This is outside the range of the bombsight so only a course correction is to be made. A reference point, "Point A," 2 1/2 miles NE or at a bearing of 45 degrees from the target is to be employed.

The R.P. is plotted on the computer disc as described, the disc turned until the angle 276 degrees appears under the index, the slide moved until the figure 200, corresponding to 20 miles, appears under the grommet and the range and bearing of the R.P. as indicated by the pencil mark, are noted in the log. These are 18.5 miles and 276 plus 6 or 282 degrees respectively. The reading is converted to slant range and set on the range circle of the radar set. The operator then waits until the check point is reached, as indicated by the R.P. response intersecting the range circle.



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At the instant of crossing, the bearing of the R.P. response is noted on the radar set to be, say, 289 degrees. This is 7 degrees greater than the predicted value, so, following the rule, the course of the aircraft is increased 7 degrees, to 283 degrees. (The exact solution gives about 282 1/2 degrees). This course is held until the next check point is reached.

Let us suppose that the next check point is the 70-degree optic angle or the clutch-in point of the bombsight. If the altitude is 23,000 feet the corresponding ground range is 10.4 nautical miles. The slide is moved until the 10A line appears under the grommet, the course is set at the corrected value of 283 degrees, and the ground range and predicted bearing of the R.P. for the new check point noted to be 9.3 miles and 296 degrees, respectively. The ground range is converted to slant range and set in as before. This time, however, a signal is given to the bombardier when the range circle intersects the R.P. response, and the sight is clutched in.

This time the bearing of the R.P. might be observed to be 293 degrees or 3 degrees less than predicted. The course is consequently decreased 3 degrees to 280 degrees and this value held over the next interval.

Assume the final check point is at a sighting angle of 50 degrees, corresponding, for the assumed altitude, to a ground range of 4.5 nautical miles. In this case the R.P. range and bearing values are read to be 3.6 miles and 313 degrees and these values are employed as before. When this point is reached the bombsight index is corrected to 50 degrees and the rate adjustment corrected as well. It is also possible to make a final small correction to the course, if required. The aircraft then continues on a straight course until the sight automatically releases the bombs.

In this example the work of the radar operator might be simply tabulated on a form as follows:

| | Check Points | | |
|---|---|---|---|
| | 20-mile | 70 deg. | 50 deg. |
| Course on Approach | 276 | 283 | 280 |
| Ground Range of Target | 20.0 | 10.4 | 4.5 |
| R.P. | "A" | "A" | "A" |
| Ground Range of R.P. | 18.5 | 9.3 | 3.6 |
| Slant Range of R.P. | 18.9 | 10.0 | 5.2 |
| Predicted Bearing of R.P. | 282 | 296 | 313 |
| Observed Bearing | 289 | 293 | 312 |
| Corrected Course | 283 | 280 | 279 |



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It should be noted that each column represents a complete checking process, the values above the horizontal dividing line being those filled in before reaching the check point, and those below being filled in afterwards. The bottom entry is the course as finally corrected after passing one check point, and this value is repeated at the top of the next column, as it becomes the approach course for the next check point.

The second line, the target ground ranges for the various check points, is filled in before the bombing run and is the same regardless of what particular reference point is employed. In fact the same check points would be used if no reference point is employed at all and the routine of the bombardier would not be affected by whether direct or offset bombing is employed.

In the example given only three check points are used, namely a preliminary course correction point to correct any large error, the 70 degree or clutch-in point and a final check point at a sighting angle of 50 degrees at which course, index position and rate may be given final corrections. It is not intended to restrict the method to three points, and there would be sufficient time for several more in this particular case. Spacing the check points close together, however, implies a greater accuracy in timing the response crossing than that of which the equipment is believed capable. The bigger the error in timing the crossing the longer the interval between crossings which is required to obtain a satisfactory measure of ground speed. It is possible that an intermediate point at 60 degrees might be helpful, but any beyond this would be expected only to complicate the routine and increase the tendency to gross errors. The analogy to the use of the bombsight in a visual aiming should not be carried too far.

It will be noted that nothing has been said about the drift angle or the process known as "killing the drift." With the above described method the approach path approximates a straight line and it is justifiable to assume a constant drift angle except where a fairly large turn may be required at the 20-mile point. In this case the navigator should use the found wind to determine on the computer the heading required to make good the specified course, and the same drift angle used thereafter.

IV. POSSIBLE USES OF REFERENCE POINT PROCEDURE IN NAVIGATION AND FLIGHT TO THE BOMBING RUN.

The method just described is based on the use several times during the bombing run of a particular procedure involving the E-6B computer. This procedure may have important other applications wherever it is required to adhere to a particular flight plan more accurately than is possible with ordinary DR navigation. This is the case in the approach before beginning the bombing run, and the method may be equally valuable whenever a course must be accurately flown to avoid enemy flak concentrations, etc. For example, many islands held by the Japanese lie in a line between Saipan and Japan. It is desirable to use these in radar navigation to and from Japanese targets without exposing the attacking force to needless flak risk.



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The method provides a straightforward procedure permitting the attacking force to pass over selected points marked on the chart to one side of an island with the same accuracy which would be obtained if the course passed directly over it.

The method is essentially the incorporation of the ordinary range and bearing radar fix into an automatic procedure for correcting the course of the aircraft to pass over any desired point, and for very accurately estimating the time of arrival.

For example assume it is desired to pass through a point which might be called a "homing point" 5 miles due east of a particular island known to give a good and sharp response. The point is marked on the navigator's chart and a line drawn back from the point along the reciprocal of the initial course determined by DR. Check points would marked at 30, 20 and 10, and perhaps 5 miles back from the homing point along this line, and the standard reference point procedure described above for the bombing run applied successively at each of these points, the only difference being that the navigator rather than the bombardier would be notified when the point is reached, and the time would be noted on the navigator's watch rather than used in correcting the bombsight. Course would be corrected exactly as in bombing. It is believed that only the first correction in course should be larger than a few degrees, and that only one correction at most would have to be applied to the course line drawn back from the homing point. Small corrections of course would not affect the estimated time of arrival at the homing point.

It is believed that it would be particularly desirable to perform this homing proce s just before beginning the bombing run, using a reference response perhaps thirty miles out from the target, in addition to the reference point near the target to be used later in the bombing run. The turn at the IP might be at such a homing point, which could be located without any restriction as long as a suitable reference point is somewhere near, say within 6 miles. In radar bombing a known response has frequently been employed for the I.P. and use of the reference point procedure would give greater freedom in planning and make it unnecessary to plan the route to pass in line with known responses. A further advantage, however, arises from the fact that it cannot always be determined in advance which of several possible reference points will give a satisfactory response, and the availability of a suitable reference point technique gives freedom in the choice of route into the target, which can be definitely fixed in advance.

The same reasons make navigational use of the method just described appear very desirable. Good DR navigation is based on adherence to a predetermined flight plan, and becomes impossible or degenerates into pilotage if deviations from the planned course are frequently made in order to pass over landmarks. Similarly, if the radar operator alters course to pass from one radar response to another, DR navigation is necessarily given up and radar pilotage substituted. Reference point procedure, on the other hand, permits more accurate adherence to an original flight plan and gives

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highly accurate fixes along the intended route. The alterations in course required by the method are not deviations from the flight plan but are small corrections to insure that the original plan should be flown with the maximum possible accuracy. The method should help make the radar operator and DR navigator into a DR navigational team making maximum use of radar as a navigational aid.

## V. DISCUSSION

If the method outlined proves operationally feasible, its use should permit the error on normal runs to be reduced from 1 or 2 miles to something of the order of 700 yards. This would make feasible radar-bombing attacks on our typical strategic targets using present AN/APQ-13 equipment, and synchronization of the bombsight and determination of the course over the target could be made closely enough to be a real aid in visual bombing through broken cloud. Otherwise, it is felt strongly that the equipment is suitable only for the bombing of urban areas generally and is not sufficiently accurate to help in visual bombing.

It is believed that the system proposed is inherently simple and involves as few deviations as possible from the direct bombing procedure of the air crew and also makes the operational planning of the mission and the preparation of briefing material quite flexible and essentially independent of whether direct or offset bombing is employed. In addition to the study of the target area for suitable reference-point responses the method merely requires the measurement on a map of the ranges and bearings from the assigned aiming point of any such responses likely to be useful.

Both in direct bombing and in the proposed offset procedure the same check points would be employed by the bombardier, who, as indicated earlier, would not be concerned with whether the bombing were by the direct or offset method. In the case of direct bombing the predetermined data for the various check points are set directly into the bombsight. In offset bombing two additional steps are interposed, first, that of reading from the computer the reference point range for each target range, and second, the stop of converting this slant range before setting into the radar equipment. Any course corrections after passing the 20-mile point are small and can be made just as easily in the offset as in the direct bombing case. This is because the first correction, just as those toward the end of the bomb run, can be made as accurately as the bearing of the reference point can be read on the scope, and no large error can accumulate. A straight course can be accurately flown to the target for a sufficient length of time to permit good formation bombing.

It is believed that the success of the method will depend on how reliably the reading of the computer and the conversion to slant range can be performed and on how smoothly the crew drill can be worked out. If the method is adopted this use of the computer should be taught just as thoroughly to radar navigators as the usual use in solving course-wind-heading problems is taught in DR navigation training. It is not a freak use of the instrument, however, and it makes use of exactly the same procedure which has already been learned in another application. The

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theory is simple and the navigator can visualize the process and understand what he is doing--a factor greatly reducing the tendency to error.

It is felt that the bombsight technique removes some previously valid objections from reference point or offset bombing methods generally. As pointed out earlier special range data for the various sighting angle check points must be determined in the aircraft for the operational altitude, regardless of whether direct or offset bombing is employed, and the process is not much more complicated on a reference point basis than for direct bombing.

Finally, since reference point methods seem to offer the only possibility of successfully bombing our typical strategic targets with present radar equipment, extensive efforts to find a really workable system clearly seem to be called for. It is hoped that the proposed system can be fully tested experimentally in this country along with any others which appear suitable, and instruction in the best method incorporated in the present training program as soon as the essential requirements have been met.

sgd/ W. N. Tuttle,
W. N. TUTTLE,
Operations Analyst.

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8 March 1945.

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION.

Subject: Comments on Second Air Force Memo of 22 February 1945 to Dr. Colling Regarding AN/APG-7 Operation and Maintenance Problems.

1. The problem of gaps in the scope pattern, referred to in para 2, is being worked on at highest priority at Wright Field, and it is believed that the situation will improve rapidly. Meanwhile it should be noted that the synchronous technique should permit the bombsight to be pretty well adjusted before the response passes into the dark area.

2. The maintenance problems referred to in paragraphs 3, 4 and 9 are of the sort on which the manufacturers field representatives should be able to give assistance. It seems highly important that the Operations Analysis Branch and others concerned at Second Air Force Headquarters be in contact with the Western Electric representatives assigned to this job. It is understood that several of these are in the field and available, and Mr. Sharkey should be in a position to make the necessary contact. Information on equipment modifications generally, referred to in paragraph 10, should also be obtainable from this source.

3. Modification of the impact - predicting computer, referred to in paragraph 5, does not appear urgent in view of anticipated use of the sighting angle attachment. The sighting - angle procedure appears to be always preferable to use of the computer.

4. Although it is hoped that the slide rule ground speed computer, referred to in paragraph 6, will be redesigned to handle higher ground speeds, it is believed that this computer should play a different role in synchronous bombing than in impact prediction bombing. Rate correction of the bombsight rather than a predetermined ground speed determines the release point. It is believed, however, that the computer should be made available to simplify the finding of a navigational wind from which an approximate rate can be preset into the bombsight.

5. With regard to difficulties in synchronization at high ground speeds referred to in paragraph 7, it has been confirmed that the range circuits of the APG-7 equipment, even allowing for tube variations, are accurate for slant ranges out to 145,000 feet, although the built in computer for impact prediction bombing as indicated, uses ranges only out to 60,000 feet. Connections with the "interim Norden" sighting angle switch are such that a sighting angle of 70 degrees can be obtained at altitudes up to 45,000 feet, greatly increasing the time available for the required operations.



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Memo to Dr. Stearns from Dr. Tuttle, 8 March 1945.

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6. Motion of the target image between sweeps, also referred to in paragraph 7, is believed not to be a serious problem. The same thing is encountered with AN/APG-13 equipment at lower ground speeds, because of the lower sweep frequency, when sector scan is not employed, and does not appear to affect bombing accuracy to any great extent. In fact sector scan, designed to reduce this error in APG-13, seems to be seldom employed even in test bombing. With a low retentivity scope the target is seen at a series of points equally spaced in a line and it is not too difficult to judge the time of crossing to the nearest sweep. If this is true the maximum error would be half the interval between sweeps or 0.33 second with APG-7 equipment, corresponding to a range error for the case given of 245 feet. Errors of several times this value would have little effect on operational results.

W. NORRIS TUTTLE
Operations Analyst
OAI, Twentieth Air Force

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14 May 45

MEMORANDUM FOR : DR. ROBERT L. STEARNS, Chief
Operations Analysis Division, Twentieth Air Force

Subject : Notes on Eleventh Air Force Memorandum "A Method of Final Heading Correction for Radar Offset Bombing" dated 9 March 1945 and prepared by Lt. Simon A. Goldsmith, Radar Intelligence Officer.

1. This report prepared by A-2, does not cover a complete operational procedure, as the title implies, but merely a method of preparing briefing data for the Final Course Correction method of offset bombing developed some time ago by Second Air Force.

2. Thus, although the report states that " the complete bombsight synchronization procedure is maintained", no discussion at all is given of this part of the operation. Final heading correction is made at a sighting angle of 50 degrees from the offset aiming point (rather than from the target) and it seems to be assumed that this fits in with standard synchronization procedure. As a matter of fact it is most important that all check points and the final course correction be made at the preselected sighting angles from the target unless some means is available for incorporating range offset into the bombsight.

3. The essential part of the memorandum is the suggestion that final course correction data be given as a series of scales, one for each altitude range to be anticipated on the mission, the scales being marked in the center with the reciprocal of the briefed coursed and extending for twenty degrees on either side. The bearing of the CAP at the check point is noted and the corresponding correction read from the scale. Receprocal bearing are used so that when the aboserved bearing is to the left of the center of the scale a left correction will be required. Preparation of the data in the form suggested would appear to be quite laborious.

4. No mention is made of the drift angle, and "heading" and "Course" are used in same sense in the report. It is, of course, necessary that true rather than relative bearings be observed and used as the basis of the correction.

5. It is believed that the memorandum is not of sufficient importance to warrant its distribution of Operations Analysis Division.

WILLIAM MORRIS TUTTLE,
Operations Analyst

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24 Jan 45

MEMORANDUM TO CHIEF OF STAFF, Twentieth Air Force

Subject : Offset Bombing Program

1. Since offset bombing procedure requires in general the solution of a geometrical problem involving ground distances, the simplest operational offset methods seem to result from use in the radar equipment of apparatus permitting a scope marker to be set directly at a predetermined ground range, after a preliminary altitude adjustment has been made. The equipment thus automatically takes care of the difference between the ground range from the point under the aircraft to the point on the ground which is of interest and the greater slant range to the sure point resulting from the height of the aircraft.

2. Radar equipments AN/APS-15 and AN/APQ-13 which preceded AN/APQ-7 were equipped with a computor drum attached to the potentiometer used for setting the slant range of the bomb-release marker. A paper scale attached to the drum could be marked directly with release point, sighting angle or ground fange so that the slant range corresponding to the desired value of any of these quantities could be set into the equipment directly without the use of tables. In particular, ground range lines were employed in some of the offset bombing procedures used by Eighth Air Force and other units, and more recently in newly develope offset minelaying procedures. (See Naval Air Station Report dated 30 December 1944).

3. In the APQ-7 equipment, an "Impact-predicting" computor, suitable only for direct bombing, was substituted for the drum computor of the earlier equipment. The new computor not only does not permit the use of offset methods but is unsuitable, also, for the use of bombsight synchronization techniques. Accordingly, a sighting-angle attachment has been developed which is to be included in the equipment of the ships for 315th Wing.

4. It is believed that the combination of this sighting-angle attachment with the drum-computor used in earlier equipment should be adopted as the standard installation for the aircraft of the 315th Wing. This would permit the adoption of a universal bombsight synchroniza - tion method based on the use of sighting angle check points which could be employed for either direct or offset aiming. Regardless of whether or not the particular bombing procedure referred to is the

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one ultimately adopted, ( see Operations Analysis Division memorandum dated 18 November 1944), it is recommended that equipment be furnished in this form to permit the greatest tactical freedom in its use. It is believed that crews whose fundamental training has been sound can be trained in offset bombing without too great difficulty, even if the training must be done abroad, provided they are not handicapped by unsuitable equipment. The propsed equipment would permit any one of many offset methods to be employed and would insure that the introduction of an offset method would not be delayed by equipment limitations.

5. At present O. C. and R, has requested M and S.,who in turn are referring the matter to A.R.L. at Wright Field, to investigate the feasiblity of the addition of the drum computor or some equivalent arrangement to the present sighting angle attachment to APQ-7 equipment. It is believed that the program can be expedited considerably if, pending consideration of other possible arrangements by A.R.L., they be asked to supply on highest priority one equipment, based on the drum computor of the APQ-13 set, for immediate installation in the prototype B-29 airplane.

6. Preliminary investigation has been made of the technical aspects of the installation proposed. It appears that the Computor Unit (CP-7) of the APQ-13 equipment can be used with some wiring changes and a possible change in the value of the potentiometer resistance. It seems desirable that the cabling be so arranged that the cable to the sighting angle unit and tha associated control box can be unplugged and the new unit inserted directly into the system with no other changes. This may require the use of an additional junction box.

7. In view of proposed operations at higher altitudes by 315th Wing, it is believed that the anxious ranges of the altitud and slant range of the computor should be revised. It is recommended that, at least in the prototype unit, the altitude range should be from 15,000 to 40,000 feet and the slant range up to 25 statute miles (in order to include the 70° sighting angle point of high altitudes and provide for some offset in addition).

8. It is recommended that the drum chart be marked with ground range lines beginning ar 3 miles ground range and increasing to the limit of the chart. Each ground range mile interval should be divided into 5 parts, that is, there should be a ground range line every 0.2 mile. Each mile line should be marked and be slightly heavier than the intermdeiate lines.

W. MORRIS TUTTLE
Operations Analyst

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OPERATIONS ANALYSIS REPORT

Issuing Unit: Operations Analysis Division
Twentieth Air Force

Title: MODIFIED E-6B OFFSET BOMBING PROCEDURE AND S.O.P. FOR AN/APS-15 AND AN/APQ-13 EQUIPMENT

Date: 13 June 1945

Identification: Report dated 13 June 1945

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HEADQUARTERS, TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

WASHINGTON, D. C.

13 June 1945

# MODIFIED E-6B OFFSET BOMBING PROCEDURE AND TENTATIVE S.O.P. FOR AN/APS-15 and AN/APQ-13 EQUIPMENT

Report Prepared By:

/s/ W. N. Tuttle
W. N. TUTTLE
Operations Analyst

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/s/ Robert L. Stearns
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for LAURIS NORSTAD,
Brigadier General, U.S. Army
Chief of Staff, Twentieth Air Force



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C O N F I D E N T I A L

13 June 1945

MODIFIED E-6B OFFSET BOMBING PROCEDURE AND TENTATIVE S.O.P.

FOR AN/APS-15 AND AN/APQ-13 EQUIPMENT

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

13 June 1945

MODIFIED E-6B OFFSET-BOMBING PROCEDURE AND TENTATIVE

S.O.P. FOR AN/APS-15 AND AN/APQ-13 EQUIPMENT

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## I. INTRODUCTION

A procedure for use of the E-6B Computer in offset radar bombing was suggested in an Operations Analysis Memorandum, dated 18 November 1944, in an effort to overcome some of the limitations of earlier offset methods. Since that time the method has been tested in practice bombing to determine its accuracy limitations and any difficulties which might be involved in training. As a result of this work the originally proposed method of course determination has undergone some modification, and a specific procedure has been worked out for making rate corrections in the Norden sight when only two check points are employed in synchronous bombing. In the present report the revised procedure is outlined and an S.O.P. is proposed giving in separate sections for the Radar Operator, Bombardier and Pilot the successive steps in carrying out the procedure and the points to which attention should be given in order to obtain accurate results.

## II. DESCRIPTION OF REVISED PROCEDURE FOR OFFSET BOMBING

### 1. Outline of the Method.

The procedure involves a preliminary course correction 20 or 25 miles from the target, based on the observed bearing of the reference point* or "RP". Bombsight synchronization is employed using only 70-degree and 50-degree check points. At the first of these the rate motor of the bombsight is turned on and at the second both displacement and rate corrections are made, a systematic procedure for the latter having been developed based on the observed deviation of the displacement index at the second point. At both points deviations of the RP bearing from the cursor setting are observed and double corrections made as in direct bombing. For both points the E-6B Computer, in a procedure analogous to that employed in solving ground-, air-, and wind-velocity triangles, gives the RP ground range and bearing at the

*The term "reference point" is employed rather than "aiming point" in describing this method, because in contrast with some previously proposed offset methods the course of the aircraft is towards the target, rather than towards the reference point, during the entire bomb run.







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distance from the target corresponding to the sighting angle. Before reaching each check point the ground range is set on the radar range circle directly using a ground range drum computer, and the bearing is set on the cursor of the radar scope,

2. Equipment Requirements.

a. The most important requirement is that the radar set be provided with a drum computer having a chart with both ground range lines and sighting angle lines. Some of the standard charts, those having ground range lines at 0.2 mile intervals, are satisfactory, but it is desirable that the ground range calibration extend down to about two miles. The procedure as outlined makes use only of 70-degree and 50-degree sighting angles, and the 50-degree sighting angle line should be added, perhaps in a different color, to the series of standard angles employed in other bombing procedures. It is possible to use the procedure with a final check point at 52 or 53 degrees instead of at 50 degrees, but the bombardier's rate correction procedure, which is based on noting the error of the displacement index at the final check point, is made less clear cut, and provision of the additional angle is believed fully justified. When the drum computer is available with the calibrations above outlined, no charts or tables are required by the radar operator in carrying out the procedure.

The drum computers which have been provided with AN/APS-15 and AN/APQ-13 equipment permit the bombing range circle to be set only out to 15 nautical miles slant range and to the corresponding somewhat lower values of ground range. Because of this one of the fixed 5-mile range circles is used in determining the preliminary course correction point, which occurs outside the range of the drum computer for usual operational altitudes. Although the modification of procedure required is not serious, it is believed that an extension of the drum computer range to 25 miles and use of ground range calibration lines is desirable not only for this and other offset bombing methods but also to simplify ordinary navigational procedures. It should be noted that the present maximum range of the drum was determined to spread out the bomb release lines in the original impact-predicting method of bombing, and that these lines are not used in the various synchronous bombing procedures more recently developed. A maximum range of 25 miles still permits the ground range lines to be reasonably spaced so that setting can be made to 0.1 mile. An experimental drum computer calibrated to 25 miles has been obtained for offset bombing tests with AN/APQ-7 equipment, and no difficulty has been found in obtaining satisfactory operation of the circuits out to this limit.

b. Proper swinging of the compass and maintenance of the azimuth stabilization circuits of the radar set are both important, as the method involves the determination of the true bearing of the RP at three different points. No unusual performance of these components is required, however, and the method can compensate for small constant

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errors in the compass calibration. It has been found, however, that erratic compass compensation can cause appreciable deflection errors in bombing.

c. The AFCE equipment should be maintained in smooth working order. It is believed that the making of the small turns involved in the bombing run would be greatly facilitated and bombing accuracy by this and other methods improved appreciably if a displacement turn control, such as the Type A-1, could be made generally available.

3. Three-Point Procedure for Setting Course

In direct bombing, when the response of the target itself can be seen, various versions of a "drift killing" procedure have come into use to bring the aircraft on to a collision course with the target in spite of errors in the assumed drift angle or in flying the originally intended course. Perhaps the simplest form is the double-correction method, in which the shift in bearing of the response is observed between two points, the second being approximately half the distance of the first from the target. If course is altered by twice the observed shift in bearing, not only will the original error in course be corrected, but the additional course change will be just the amount required to overcome the lateral displacement which has resulted from the original error over the distance already flown. Within the limits of accuracy of making the observations and executing the maneuver the double course correction results in the aircraft turning at the second point onto a course passing over the target.

It can be shown that the same situation exists in offset bombing where the reference point may be 30 degrees or more to the left or right of the course of the aircraft. Thus if the course set at the first point deviates by 2 degrees, say, from the course to the target, the observed bearing of the reference response at the second point will differ by 2 degrees from the value it would have had if the original course had been correct. This is on the assumption that the distance to the reference point does not differ too greatly from the target distance. If the cursor of the radar scope can be preset at the bearing of the reference point response at the second point corresponding to the correct initial course, exactly the same course correction procedure can be employed in the offset case as in direct bombing. In either case, when the check point range has been reached, the cursor is moved from its preset position to the position of the response, and the heading is then altered in the same direction as the cursor has been moved and twice the amount. When the E-6B offset method is used the computer gives the value of the bearing to be set on the cursor before reaching the check point in question. The principal differences between the direct and offset procedures for course determination, therefore, are that in the latter, corrections can be made only at certain preselected points, and that the bearings at these points must be read from the computer and preset.

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The restriction on this method of course correction to cases where the reference point distance does not differ greatly from the target distance means that the method is not applicable to bombing operations where large offset distances are involved. However, the E-6B offset method is already limited to the maximum reference point distance which can be plotted on the computer face, namely six miles, so the additional restriction imposed is not serious. The formula governing the relation between the bearing of the target and the observed bearing of the reference point is the following:

$$\frac{\text{Change in target bearing}}{\text{Change in RP bearing}} = \frac{\text{Distance from aircraft to RP}}{(\text{Distance from aircraft to target}) \cos B}$$

where B is the difference in bearing between the target and the reference point. Since B is usually less than 30 degrees, cos B is approximately unity and the changes in bearing vary inversely as the respective distances. If the RP distance is half the target distance only half the required change in course would be made in following the standard procedure, but this condition would occur only toward the end of the bombing run where the residual corrections would be small in any event. The first course correction would have been made 20 or 25 miles from the target and the second at half this distance, so that even when fairly large offset distances are employed highly accurate course corrections can be made at the first two points. If the final correction under some circumstances is given less accurately, as in the case just considered, it still serves further to reduce a deflection error which will usually already have been made as small as flying errors permit. The effect is thus compensating and the method of course correction becomes less accurate only as the magnitude of the required correction becomes smaller.

It should be pointed out that at the preliminary course correction point the aircraft is merely turning onto the course to the target determined from the RP bearing, so there is no preceding run to serve as a basis for double correction. Just as at this stage in the direct bombing procedure, the cursor is moved from its preset position to the response, and the aircraft heading then altered in the same direction and the same amount.

As the E-6B offset method was originally proposed, single corrections were employed throughout. It can be shown that the single correction is proper when the course of the aircraft and the azimuth of the RP are known with greater accuracy than the position. It has been found, however, that after the preliminary course correction the principal error is not from uncertainty of position, but from error in the assumed drift angle, constant error in the azimuth reading of the radar scale, and error in the compass reading and in setting the intended course. All these latter factors are properly taken care of by the double correction procedure.

This has been borne out in preliminary tests where single correction procedure has been compared with that employing double correction as just outlined. When single corrections are used good bomb-

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ing can be performed when the drift is accurately known, but any error in the assumed drift angle shows up immediately as a deflection error. When double corrections are employed the deflection errors can be kept low even when there is a fairly large error in the assumed drift.

The entire three-point procedure, that is, the preliminary course correction at 20 or 25 miles combined with double corrections at the two check points, is believed to be a particularly simple and accurate basic procedure to which the offset determinations can be applied without making the whole bombing procedure too complicated to be taught to operational crews. Use of the basic procedure in direct bombing is discussed in section III, below.

4. Fixed-Ratio Method of Bombsight Rate Correction.

When only two check points are employed in bombsight synchronization, a long enough timing interval is provided so that any appreciable deviation of the rate of motion of the response from the preset bombsight rate shows up clearly in the position of the displacement index at the second check point. A basis is provided, therefore, for accurate quantitative correction of the rate index setting. It turns out, fortunately, that the required correction of the rate index bears approximately a constant ratio to the observed deviation of the displacement index at the second check-point position, the ratio holding over a wide range of groundspeeds and altitudes provided that the correction is made with reference to the degree scale of the bombsight rather than to the tangent scale.

If the two check points are taken at 70 degrees and 50 degrees, one degree error in the position of the displacement index at the second check point, if uncorrected, amounts to a 35-mil range error in the position of the bomb. Also, for this pair of check points, the required correction of the rate index is about 3/4 degree for each degree deviation of the displacement index at the 50-degree point. This is seen from the following table calculated for the M38A2 practice bomb.

| Groundspeed m.p.h | Correction Ratio 10,000 feet | 20,000 feet | 30,000 feet |
|---|---|---|---|
| 150 | .72 | .60 | .53 |
| 200 | .81 | .72 | .66 |
| 250 | .84 | .80 | .76 |
| 300 | .83 | .85 | .83 |
| 350 | .80 | .86 | .87 |
| 400 | .76 | .85 | .88 |
| 450 | .72 | .83 | .88 |
| 500 | .68 | .81 | .87 |

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The correction ratio also varies only slightly with the type of bomb employed, as can be seen in the following comparison at 20,000 feet of an ideal bomb, having neither trail nor time lag, with the 500-pound GP bomb AN-M43 and with the 100-pound practice bomb M38A2 for which the preceding table was calculated.

| Groundspeed m.p.h. | Correction Ratio Ideal bomb | 500-lb. bomb | 100-lb. bomb |
|---|---|---|---|
| 200 | .64 | .68 | .72 |
| 300 | .75 | .80 | .85 |
| 400 | .78 | .82 | .85 |
| 500 | .75 | .79 | .81 |

It will be seen that the required correction ratio falls off at low groundspeeds, but that at lower altitude where low groundspeeds are more likely to prevail, the falling off is less rapid. The correction ratio of 3 to 4, arbitrarily selected, seems to be a good compromise because, although it under corrects slightly at higher groundspeeds, it is satisfactory to lower values. Except for extremely low groundspeeds, it is believed that the advantages of simplicity in keeping to a constant correction ratio more than compensate for any loss of accuracy involved.

Preliminary tests indicate that this fixed-ratio method of rate correction is easily learned and greatly reduces range errors. As discussed in the bombardier's section of the S.O.P., it is able to compensate for any reasonable variation of groundspeed, say of 20 or 25 miles per hour, from the value which would be estimated using the navigational wind. It is most effective, however, if used to compensate for only moderate variations, and care should be used to preset the dropping angle as accurately as the data permit. Use of proper dropping angle tables is discussed in the bombardier's section of the S.O.P.

## III. SIMPLIFIED DIRECT-BOMBING PROCEDURE BASED ON OFFSET METHOD

It is believed that the 3-point course correction procedure, without offset, combined with the fixed-ratio method of bombsight rate correction, employing two check points, is a particularly simple and accurate procedure and should be considered for operational use, particularly where time is not available for training in the use of offset. Although only preliminary results have been obtained it is believed that the accuracy compares favorably with that of any other method so far tried which does not require elaborate auxiliary equipment. The work of the radar operator is very much simplified over that required by other methods and even operators with a minimum of training should have ample time to perform the required operations.

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In this procedure the radar operator merely makes a single correction at the 20 or 25 mile point, and two double course corrections, one at each of the two bombsight check points. The two required values of ground range are set in directly from the sighting angle lines of the drum computer. No use is made of the E-6B computer during the bombing operation. The modifications of the radar operator's S.O.P. for direct bombing will be obvious, and the S.O.P.'s for the bombardier and pilot are exactly as given in the following section.

## IV. PROPOSED S.O.P. FOR OFFSET BOMBING

### 1. Pre-Mission Planning and Reconnaissance.

Good reconnaissance, target study and briefing are just as essential for offset bombing as for direct bombing. Although, as will be noted later, the method permits immediate shift from one RP to another or to direct bombing during the bombing run, it is nevertheless highly desirable that reference points should be selected that can be seen reliably over a fairly wide range of distances and bearings. This is difficult, and sharpness of response must frequently be sacrificed for reliability of pickup in the selection of possible RP's. After the most suitable points have been selected, it is merely necessary that their distances and bearings from the target should be scaled to the nearest 0.1 mile and the nearest degree, if possible, and these data included in the briefing material. The method is suitable for offset distances up to 5 miles. Where only a single RP is available the directions of approach should be avoided, if possible, which place the RP between the aircraft and the target during the bomb run.

### 2. Detailed S.O.P. with Discussion.

#### a. Before Takeoff

##### (1) Radar Operator

(a) Before takeoff the location relative to the target of several reference points or RP's in the target area which might be suitable for offset bombing is plotted on the face of the E-6B computer. The only required data are the ranges and bearings of the points relative to the target. The points are plotted by the procedure used for the points of wind vectors, but in the reverse direction. The angular scale is turned to the true bearing of the point from the target and, using the velocity scale on the slide as a measure, a point is marked a distance out from the grommet toward the index corresponding to the range. One nautical mile is made to correspond to 10 knots in the usual use of

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the computer, so that a small division is equal to 0.2 mile. The edge of the face is six miles from the target but offset distances greater than 5 miles should not in general be employed. Extreme care is not necessary in plotting but the effort should be made to mark the points clearly to the nearest 0.1 mile. It is helpful also to mark on the computer face additional information such as the general configuration of the coastline, the boundaries of the town, etc., so that the RP's are included in a simplified map of the expected response of target area.

(b) Before takeoff a "dry run" is made with the E-6B computer to be sure that the RP's selected can be utilized without difficulty at the bombsight check points. It is only necessary to try the conditions at the 50° check point, as these are most critical. To make the test, a mark is made on the center line of the 3-30 mile side of the computer slide at the ground range of the 50° check point corresponding to the approximate bombing altitude. The slide is moved until the mark comes under the grommet and it is made certain that any RP's to be used in bombing do not appear off the end of the slide, or too far abeam, for reasonable angular deviations from the briefed direction of attack. Difficulty will be encountered only when the RP is on the near side of the target, and the point to be used should be selected in the semicircle back of the target whenever possible.

(c) Also before takeoff, the fixed range circle to be used for the preliminary course correction point should be determined and entered in the "RP Ground Range" space in the bombing form. As indicated in the discussion of equipment, this step is necessary only because of the limited range of the drum computer. If the drum computer could be made available with slant ranges out to 25 miles, the preliminary course correction or "PCC" point would always be taken at twice the target ground range of the 70° check point (to the nearest mile) and the preliminary course correction point would be handled like the 70° and 50° check points. Because of the equipment limitation it is desirable to determine which 5-mile range circle comes nearest to satisfying this condition. This is illustrated in the following table:

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Target Ground Range in Nautical Miles

| Altitude | PCC | 70-Degrees | 50-Degrees |
|---|---|---|---|
| 5,000 | 4.5 | 2.3 | 1.0 |
| 10,000 | 9.0 | 4.5 | 2.0 |
| 15,000 | 13.6 | 6.8 | 2.9 |
| 20,000 | 18.1 | 9.0 | 3.9 |
| 25,000 | 22.6 | 11.3 | 4.9 |
| 30,000 | 27.2 | 13.6 | 5.9 |
| 35,000 | 31.6 | 15.8 | 6.9 |

It will be seen that for altitudes up to between 15,000 and 20,000 feet the range of the drum computer is adequate. For altitudes between 20,000 and 25,000 feet the 20-mile range circle should be used, and for altitudes from 25,000 to 30,000 feet the 25-mile circle comes nearest to the optimum range. At these ranges the difference between slant range and ground range is small, 0.3 to 0.4 mile, and can be neglected in view of the fact that only a course correction is made at the PCC point and only approximate range information is needed in determining the bearing of the RP response. For the same reason the 5-mile range circles, although not intended for bombing, are accurate enough to locate the preliminary course correction point provided they are kept in approximate adjustment by checking occasionally against the 15-mile slant range point of the drum computer.

It was noted that the range of the circle selected is entered in the "RP Ground Range" space in the bombing form, although the condition to be satisfied relates to the target ground range. The values given consequently apply strictly only when the RP distance is approximately equal to the target distance. Allowance should occasionally be made, therefore, for the RP distance from the target. If the RP is 5-miles in back of the target, for example, the next 5-mile range circle at greater range should be used. The PCC distance is not critical, but the factors given should be considered so that the PCC point can be taken within 3 or 4 miles of the optimum range.

(2) Bombardier

(a) A table of dropping angles for various groundspeeds and altitudes should be available, or should be prepared

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before takeoff from the new standard form bombing tables. This is done by taking the average bombing IAS for the type of aircraft employed by the unit, computing the TAS for various pressure altitudes, assuming the temperature of a standard atmosphere, taking the corresponding trail and time of fall from the bombing tables, and determining from these the dropping angle for the required range of groundspeeds. An alternative procedure is to determine the TAS as above, compute the range wind as the difference between the groundspeed and the TAS, and apply the range wind correction to the dropping angle given in the tables. It should be noted that the range wind correction can amount to two or three degrees in dropping angle at high and low groundspeeds even with a good bomb, whereas reasonable variations from normal bombing IAS of a particular type of aircraft or of temperature from that of a standard atmosphere can amount to only a fraction of a degree. Although the new procedure for rate correction employed with this method of bombing can correct quite accurately for normal errors in estimated groundspeed, it is much more effective if the corrections can be kept small by using proper dropping angle tables and using care in the estimation of groundspeed and setting the corresponding dropping angle into the bombsight. An example of a dropping angle table prepared as recommended is given as Appendix II. It is believed that accurate dropping angle tables as described above are equally desirable in other radar bombing methods employing bombsight synchronization. They are particularly useful, also in facilitating accurate wind determinations by the bombardier during periods when ground detail can be observed, without changing the settings of the bombsight for the bomb run.

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b. En Route to IP

(a) En route to the target area and before the turn at the IP the radar operator should make several radar wind determinations and should cooperate with the navigator in wind finding, so that a reasonably good navigational wind for the target area is obtained and checked. Normal errors in drift and in groundspeed resulting from errors in wind are taken care of in the bombing procedure, but it is important to avoid gross errors in the wind used. Wind is marked on the E-6B computer in the usual way, care being taken to avoid confusion with the reference point markings.





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(b) The altimeter correction is taken from the forecast data or determined by radio altimeter, and the bombing altitude over target checked with the bombardier. Flying altitude for the bomb run is checked with the pilot.

(c) Indicated air speed for the bomb run is checked with the pilot and true air speed computed from the altitude and corrected temperature, or obtained from the navigator.

(d) The estimated approximate groundspeed and drift for the bomb run are given to the bombardier some time before reaching the IP to permit setting up the bombsight.

(e) Variation setting for the target area should be set into the Fluxgate compass.

(f) The altitude line of the drum computer is set at the bombing altitude and the ground range corresponding to 70-degree and 50-degree sighting angles read from the drum, noted in the bombing form and marked on the center line of the slide of the E-6B computer. As in plotting the RP's on the computer face, extreme care is not required, but the drum should be read and the distances marked on the slide to the nearest 0.1 mile if possible.

(g) When the IP is approached the radar operator, making use of the best wind available on the E-6B computer, estimates the heading required to make good a course from the IP to the target and instructs the pilot when to make the turn and to what heading. Although the bombing procedure permits large changes in course to be made after the turn at the IP, the later work is simplified if the IP turn can be made to within 5 or 10 degrees. This does not mean within 5 or 10 degrees of the briefed course but of a collision course to the target from whatever point last minute difficulties may require the turn to be made. The method permits any direction of approach, at least within a semicircle, without any modification of the planned procedure. The IP turn should be made far enough from the target to give at least two minutes after completing the turn before the preliminary course correction point, 20 or 25 miles from the target, is reached.

(2) Bombardier

(a) As soon as the bombing altitude has been determined trail and DS should be set into the bombsight in the usual manner.

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(b) As with other methods of bombing, a bombsight wind and drift should be determined prior to reaching the IP, whenever conditions permit, and given to the radar operator and navigator as a check on winds determined by other methods. The corrected dropping angle table should be employed in any such determination as discussed in paragraph a(2)(a) on page 10.

(c) Before reaching the IP the estimated groundspeed and drift for the bomb run should be obtained from the radar operator, and the corresponding dropping angle, determined from the table referred to in paragraph 1, should be set into the sight.

(3) Pilot

(a) The AFCE should be set up early in the mission so that it can have ample time to warm up and so that it can be used in wind determinations during the navigational part of the flight before reaching the IP. Leveling should be done carefully to prevent deflection errors from this source in bombing. After initial adjustments the AFCE should be left alone as much as possible. If readjustment is necessary, it should be completed before reaching the IP. It is particularly important that settings should not be disturbed during the bomb run.

(b) Before reaching the IP the pressure altitude to be held during the bomb run should be checked with the radar operator and bombardier. Also the IAS for the bomb run, allowing for any effect of open bomb bay doors, should be agreed on with the radar operator.

(c) As the IP is approached the directional gyro is set to match the reading of the Fluxgate compass, in order to prepare for the IP turn.

(d) When the turn is called for by the radar operator it should be commenced promptly and made at a rate of one-half needle width. The aircraft should be brought out of the turn to make the directional gyro read the heading called for without reference to the compass. Unless this precaution is observed the heading arrived at may be in error by several degrees, as it has been found that the "turning error" of the Fluxgate compass is generally 4 or 5 degrees, and two minutes or more are required after completion of the turn before the correct heading is indicated.

c. After the IP Turn

(1) Radar Operator

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(a) The heading, drift and course are entered in the bombing form and the angular scale of the E-6B computer turned to the estimated course. As soon as one of the RP's is identified the slide is moved until the plotted point for the RP is at the 5-mile range value which has been selected and entered as "RP Ground Range" for the preliminary course correction point. The expected true bearing of the RP is noted from the E-6B computer (by adding the relative bearing from course to the course, using the drift scale at the top of the computer) and this bearing is set on the cursor of the radar scope. Particular care should be exercised in noting the cardinal lines of the azimuth scale each time a setting of the cursor is made, so that 314 degrees is not read as 324 degrees, for example. This type of error can easily be made and has been found responsible for some of the gross errors in bombing by this method. The heading marker line is turned off and not used during the bombing run.

At low enough altitudes to permit use of the drum computer at the PCC point, or if a drum computer with a 25-mile range is made available, the procedure, as at the bombsight check points following, would be to start with the target range set under the target mark, the grommet, and to read and set the RP range. The log entry makes clear whether the target range or the RP range is the given quantity, and it has not been found that any confusion results at this part of the procedure. In the sample bombing log, Appendix I, it will be noted that in the column for the PCC point the figures 20.0 are entered as "RP Ground Range" and the "Target Ground Range" space is left blank. If sufficient range had been available on the computer drum, the optimum PCC target range, 18 miles for the altitude given, would have been entered in the "Target Ground Range" space, and the corresponding RP ground range would have been read from the E-6B slide and set on the drum computer as soon as the approximate course was known after the IP turn. It will be seen that the log entry, made before takeoff, makes it clear whether target range or RP range is the quantity given at the start.

(b) The 5-mile range circle which has been selected for the preliminary course correction is carefully identified, or the proper value set in on the drum computer if the bombing altitude is below 20,000 feet. The RF response is watched as it moves in towards the range circle. If it is seen that the response will cross the range circle

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to the left of the cursor, a left course correction will be required, and vice versa.

(c) When the RP response crosses the range circle the cursor is moved to the response and the pilot is instructed to alter heading in the same direction and the same number of degrees as the cursor is moved. The observed bearing and the correction are noted in the log, and the corrected course obtained by applying the correction to the previously assumed course. It is important that this and the later turns should be ordered without delay when the response intersects the range circle. After the turn at the IP all subsequent turns are ordered as so many degrees right or left and without reference to the actual heading. After each turn the radar operator should refer to the compass, however, to check that the turn has been made in the direction ordered and approximately the right amount. He should not be concerned with small errors in setting heading because, due to the Fluxgate compass turning error referred to in the Pilot's section, the pilot, using the directional gyro, is in the best position to make an accurate turn. Moreover, except at the final check point, any error in setting heading is automatically taken care of at the next check point by the double correction procedure. In order that bearings can be observed accurately on the radar scope, range expansion should be utilized, if available on the particular radar set employed, to keep the RP response near the edge of the scope.

(d) Using the new course, the groundspeed and drift are determined from the computer and the values given to the bombardier so that the bombsight settings can be corrected if necessary. No later determination of these quantities is required and the rate setting made at this time is modified only by the "fixed-ratio" correction procedure at the 50° check point.

(e) With the new course under the index of the computer, the slide is moved until the 70-degree check point mark comes under the grommet and the expected bearing of the RP at that point read as before, noted in the bombing form and set on the cursor. The ground range of the RP at this point is also read from the slide, noted in the form and set on the ground range scale of the drum computer.

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(f) The RP response is watched as before as it approaches the range circle. This time, at the instant of crossing, the bombardier is instructed to turn on the bombsight rate motor (or clutch in the sight, whichever method is preferred). It is important that a clear cut routine be employed in calling the crossings to the bombardier; for example, "ready --ready -- ready -- now!" The cursor is moved to the response and this time a double correction is made and the pilot is instructed to turn in the same direction and twice the amount that the cursor was moved. The observed bearing and the correction (undoubled) are noted in the bombing form.

(g) The correction is applied, undoubled, to the course which was assumed for the leg just completed and the setting of the E-6B computer modified until the corrected value of the course comes under the index. Note that regardless of whether a single or double correction of heading is ordered during the bomb run, only a single correction is applied to the previously assumed course to obtain the value to be used on the E-6B computer in determining the data for the next check point. This makes for a particularly simple procedure, and the radar operator need not be concerned with the actual value of the heading after he has made his original estimation of course after the IP turn. The slide is moved until the mark for the 50-degree check point comes under the grommet, and the values of true bearing and ground range for the RP response noted and set on the cursor and drum computer, respectively, as before.

(h) The instant of crossing of the range circle is announced to the bombardier, as at the 70-degree check point, and a double correction of heading is again made. This is the final correction.

(2) Bombardier

(a) After the preliminary course correction following the turn at the IP, a final estimate of groundspeed for the bomb run will be obtained from the radar operator and used in correcting the dropping angle previously set into the sight. The estimated groundspeed and the preset DA in degrees should be entered in the bombardier's log. Although, in view of the new procedure for rate correction, it is not necessary to preset the dropping angle with extreme care, nevertheless errors will be reduced if the required corrections are kept small and the dropping angles determined and preset at least to the nearest degree. The correction procedure is only approximate

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and is difficult to do accurately. It can be highly effective, however, if too much is not asked of it, and every effort should be made to get the groundspeed to the nearest 5 or 10 mph and to preset the corresponding dropping angle.

(b) The bombardier prepares to start the sight as the 70-degree check point is approached. As the clutch sometimes fails to engage when the control is first operated, the preferred procedure is to engage the clutch, turn off the motor, set the displacement index at 70 degrees and wait for the signal from the radar operator. The rate motor switch is snapped on the instant the signal is received and only a small fraction of a second is lost on starting. As indicated in the discussion of the radar operator's procedure, a clear-cut routine should be established for signalling the instants at which the check points are reached.

(c) When the signal for the 50-degree check point is received, the displacement index is immediately moved to the 50-degree mark and the amount of the correction in degrees borne in mind. The inner knob is then immediately moved in the same direction enough to cause the rate index to move about three-quarters of the correction which has just been made to the displacement index. Turning the knobs in the same direction results, of course, in the correction of the index position being in the opposite direction. This procedure is correct only if the setting of the rate index is noted with respect to the reading of the angular scale and not of the tangent scale. Although the rate index is not adjacent to the angular scale, it has been found that if ordinary care is used the setting can be made with the required accuracy with little difficulty. As an example of rate correction by this method, if the present DA is 30 degrees and the displacement index at the 50-degree check point is at 52 degrees, the displacement index is first moved to 50 degrees and the rate index then moved to 31.5 degrees. If the displacement index was at 46 degrees, the final position of the rate index should be 27 degrees. The corrections need not be calculated, a quick estimate being all that is necessary. If the rate index can be correctly set to the nearest half degree, rate errors due to bombsight manipulation will be negligible. This requires a reasonably good preset

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DA and avoidance of gross errors in making the correction, rather than concern about tenths of a degree in the final setting.

(d) As soon as the rate correction has been completed, the trigger should be made ready for release. The observed position of the displacement index at the 50-degree check point should then be noted in the log.

(e) After bomb release the actual final position of the rate index should be read on the angular scale and noted in the log. This is particularly important in practice bombing, but it is believed that it also helps in establishing and maintaining the proper routine on operational missions.

(3) Pilot

(a) After the IP turn the pilot should concentrate on maintaining as smoothly as possible the pressure altitude and IAS that have been agreed upon with the radar operator for the bomb run.

(b) Preparation should be made for the preliminary course correction 20 or 25 miles from the target. This correction and the subsequent corrections will be called for as so many degrees left or right. These corrections, like the IP turn, should be made using the directional gyro and should be made at a rate of one-half needle width. These later turns, however, should be made without reference to the actual heading involved. If a turn of 8 degrees right is called for, the turn should be made so that the reading of the gyro is increased 8 degrees from whatever reading it may have had when the turn was ordered. This is because a small error in setting the last heading will be taken care of automatically at the next check point, but this is only true if the later turns are made as the changes ordered, without regard to the actual heading. It is also important that turns should be made promptly when ordered and then let alone. If it is found when part way along a leg that the gyro reads one or two degrees different from the intended final reading when the turn was made, no correction should be made, as the error will be corrected by the normal procedure at the next point. It has been found possible with a little practice to go into a small turn and come out with an average error of about a degree. If a larger error is made it can immediately be corrected, but no further changes should

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be made before the next check point. The 3-point course-correction procedure which is employed is based on the assumption that straight legs are flown between check points. It is more important, therefore, that turns should be made promptly and then let alone than that individual turns should be made with extreme care. The error of making turns in the wrong direction happens often enough so that it should be guarded against by the pilot first concentrating his attention on the required direction and then on the required amount of turn.

(c) The 70-degree course correction is made when called for by the radar operator using the same procedure just outlined.

(d) The final course correction is made at the 50-degree check point, again using the same procedure.

(e) After the final course correction the same IAS, altitude, and heading should be maintained until after bomb release and for any additional time necessary for strike photos. If after the 50-degree correction point, however, the IAS is found to have been different during the bombing run from the value intended, it should be maintained at the same value and not changed until after bomb release. This is because the bombsight rate will already have been corrected to correspond to the actual speed between the 70-degree and 50-degree check points.

3. Summary Outline of S.O.P.

a. Before Takeoff

(1) Radar Operator

(a) Scope photo study. Selection of RP's. Scaling of RP distances and bearings from target and plotting on E-6B computer face.

(b) Check on computer suitability of RP's at 50-degree check point.

(c) Determine distance for preliminary course correction point, mark on computer slide and enter in bombing form.

(2) Bombardier

(a) Check bomb load and obtain corrected table of preset dropping angles.

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b. En Route to IP

(1) Radar Operator

(a) Radar wind finding. Check wind with navigator and mark on E-6B computer.

(b) Check bombing altitude with bombardier and pilot.

(c) Check IAS for bomb run. Compute TAS.

(d) Give estimated bombing GS to bombardier.

(e) Set target area variation in Fluxgate compass.

(f) Determine 70-degree and 50-degree check point ground ranges from drum computer and mark on E-6B.

(g) Call time of turn and heading at IP.

(2) Bombardier

(a) Check bombing altitude and set DS and trail.

(b) Get bombsight wind when possible and check with radar operator and navigator.

(c) Get estimated GS and drift for bomb run from radar operator and preset drift and DA in bombsight.

(3) Pilot

(a) Set AFCE and level ship carefully.

(b) Check altitude and and IAS for bomb run.

(c) Set gyro for IP turn.

(d) Make IP turn using gyro to final heading called for.

c. After the IP Turn

(1) Radar Operator

(a) Determine RP bearing for preliminary course correction point and set on cursor.

(b) Check or set corresponding range circle.

(c) Call single heading correction when response intersects circle.

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(d) Give final groundspeed and drift data to bombardier.

(e) Correct assumed course in bombing form, read RP bearing and ground range for 70-degree check point from E-6B computer, and set on cursor and computer drum.

(f) Notify bombardier when response intersects range circle for turning on rate motor at 70-degree check point. Order double correction of heading.

(g) Apply single correction to previously assumed course in bombing form and using this corrected course on the E-6B computer, proceed as before to read and set range and bearing for 50-degree check point.

(h) Notify bombardier when response intersects range circle for 50-degree check point. Order double correction of heading. This is the final correction.

(2) Bombardier

(a) Correct DA and drift settings when radar operator gives final estimated groundspeed and drift.

(b) At 70-degree check point start rate motor.

(c) At 50-degree check point correct displacement index and make 3/4 correction of rate index, using degree scale.

(d) Set trigger for release.

(e) After release record final position of rate index.

(3) Pilot

(a) Maintain bomb run IAS and altitude.

(b) Make preliminary course correction using gyro.

(c) Make heading correction at 70-degree point using gyro.

(d) Make heading correction at 50-degree point using gyro.

(e) Maintain IAS and heading until after release and photos.



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V. DISCUSSION

1. Flexibility of Procedure

One characteristic of the method which should be discussed is its flexibility with regard to changing from one RP to another or from use of a reference point at the start of the bomb run to direct bombing, if the response of the target itself should be picked up later. This is believed important, as many sharp identifiable responses persist only over a relatively short interval. In approaching the target area, moreover, the RP response preferred for determining final release may not be visible at the preliminary course correction point. In this case any other response which has been marked on the computer face can be used just as readily, without any modification of procedure. This is because all check point distances have been determined and marked relative to the target and not relative to the RP, and the differences in bearing and range involved in using an RP are only taken into account when they are read from the E-6B computer face just before making the range circle and cursor settings of the radar set. Each check point is independent of the others, and the data for any point visible can be set in immediately.

2. Use of Bombing Form by Radar Operator

Use of a form for noting the initial heading and course, the range and bearing information, and the course corrections, is recommended as part of the procedure. This is not for the purpose of making computations, however, as none are required except the addition of the successive course corrections so that the corrected assumed course can be kept set on the E-6B computer. All other quantities are determined directly from the computer readings. The procedure does involve repeatedly, however, the reading of quantities as numerical values, and the transfer of these values to the E-6B computer, or to the computer drum or azimuth scale of the radar set. It is believed that noting down such numerical quantities before resetting them aids materially in reducing errors. Furthermore if the successive entries in the form are followed, little effort is required in performing the operations in the correct sequence. The advantages of the form for checking the operator's performance, both on operational missions and on training flights, seem obvious. An example of a suitable radar operator's form, filled out for a typical bombing run and with the preliminary wind information, etc., is attached to the report as Appendix I.

3. Bombardier's Log

In the case of the bombardier, it is believed useful, both on operational and practice bombing missions, to record the final estimate of groundspeed and the corresponding dropping angle which is preset into the bombsight. Although no reference to written figures is required in the method employed for rate correction, it is believed that, as in the case of the radar operator, it helps in establishing and maintaining a proper routine in the work if the correction data are also recorded after

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completion of the run. Typical data for a practice mission on which eight bombs were dropped are given in the following table:

| Run No. | Course | Assumed GS | Set DA | 50° Reading | Final DA |
|---|---|---|---|---|---|
| 1 | 153 | 237 | 28.8 | 51 | 29.2 |
| 2 | 251 | 190 | 24.7 | 48.5 | 23.7 |
| 3 | 153 | 237 | 28.8 | 50 | 28.8 |
| 4 | 060 | 245 | 29.9 | 52 | 31.4 |
| 5 | 153 | 232 | 27.9 | 50.5 | 28.4 |
| 6 | 240 | 190 | 24.7 | 53 | 27.9 |
| 7 | 153 | 237 | 28.8 | 51 | 29.2 |
| 8 | 060 | 245 | 29.7 | 52 | 31.0 |

The final dropping angle, given in the last column should be recorded as actually read from the scale after completion of the run. The change from the preset value can then be checked to see to what extent the bombardier has been able to make the corrections called for by the procedure.

4. Training Requirements

Estimated minimum training time based on experience in test bombing to date is as follows:

a. Lecture explanation including practice in use of E-6B computer on the offset problem.

b. Two periods of about two hours each on the supersonic trainer.

c. Two flights, at least one including the dropping of 5 or more practice bombs. The other flight can be camera bombing but should include at least 5 simulated bombing runs.

Operators who have proved good navigators have little difficulty in learing the procedure. The tendency is to do good bombing on the first practice flight, but this should not lead to shortening the training program or difficulties are likely to occur on later flights. The procedure should be practiced long encugh so that the steps become habitual and the operator develops sufficient confidence so that he does not hurry.

W. N. TUTTLE
Operationas Analyst

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APPENDIX I

FORM FOR E-6B OFFSET BOMBING

Target _____ Aircraft _____ Date _____

Radar OP. _____ Pilot _____ Bombardier _____

Preliminary Data (Fill in before reaching IP)

Pressure Alt. 19,300 Corr. 700 Abs. Alt. 20,000

IAS 155 mph Temp. -22°C TAS 211 mph

Winds: Metro 240/55 mph Radar 225/50 mph Used 225/50 mph

Heading 064 Drift 4L Course 060 GS 260

Corrected Data for Bombardier (Fill in after PCC turn)

Heading 077 Drift 6L Course 071 GS 255

Bomb Run Data

RP Comm. Pt. Range 2.6 n.m. Bearing from Target 105°

Initial Heading 070 Drift 5L Initial Course 065

| | PCC | 70° | 50° |
|---|---|---|---|
| Course | 065 | 072 | 068 |
| Target Ground Range | | 9.0 | 3.9 |
| RP Ground Range | 20.0 | 11.2 | 6.2 |
| Predicted RP Bearing | 070 | 079 | 083 |
| Observed RP Bearing | 077 | 075 | 085 |
| Correction | 7R | 4L | 2R |

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APPENDIX II

BOMB, G.P., 500-LB., AN-M43

TABLE OF DROPPING ANGLE IN DEGREES

FOR OPERATIONAL AIR SPEEDS OF B-29 AIRPLANE

| ALT. FEET | IAS | GROUND SPEED - MILES PER HOUR | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 |
| 5,000 | 243 | 36.3 | 38.2 | 40.0 | 41.8 | 43.4 | 45.0 | 46.4 | 47.8 | 49.2 | 50.4 | 51.6 | 52.8 |
| 6,000 | 241 | 33.6 | 35.4 | 37.3 | 39.0 | 40.6 | 42.2 | 43.7 | 45.1 | 46.4 | 47.7 | 48.9 | 50.1 |
| 7,000 | 240 | 31.3 | 33.1 | 34.9 | 36.6 | 38.2 | 39.8 | 41.3 | 42.7 | 44.0 | 45.3 | 46.6 | 47.8 |
| 8,000 | 238 | 29.5 | 31.3 | 33.0 | 34.6 | 36.2 | 37.8 | 39.2 | 40.7 | 42.0 | 43.3 | 44.6 | 45.8 |
| 9,000 | 236 | 27.8 | 29.6 | 31.3 | 32.9 | 34.5 | 36.0 | 37.5 | 38.9 | 40.2 | 41.5 | 42.8 | 44.0 |
| 10,000 | 235 | 26.4 | 28.1 | 29.8 | 31.4 | 32.9 | 34.4 | 35.9 | 37.3 | 38.6 | 39.9 | 41.2 | 42.4 |
| 11,000 | 233 | 25.2 | 26.8 | 28.5 | 30.0 | 31.6 | 33.0 | 34.4 | 35.8 | 37.2 | 38.5 | 39.7 | 40.9 |
| 12,000 | 231 | 24.0 | 25.7 | 27.2 | 28.8 | 30.3 | 31.8 | 33.2 | 34.5 | 35.9 | 37.1 | 38.4 | 39.6 |
| 13,000 | 229 | 23.0 | 24.7 | 26.2 | 27.7 | 29.2 | 30.6 | 32.0 | 33.3 | 34.7 | 35.9 | 37.2 | 38.4 |
| 14,000 | 227 | 22.1 | 23.7 | 25.2 | 26.8 | 28.2 | 29.6 | 31.0 | 32.3 | 33.6 | 34.8 | 36.1 | 37.3 |
| 15,000 | 225 | 21.3 | 22.9 | 24.4 | 25.8 | 27.2 | 28.6 | 30.0 | 31.3 | 32.6 | 33.9 | 35.1 | 36.2 |
| 16,000 | 223 | 20.6 | 22.1 | 23.6 | 25.0 | 26.4 | 27.8 | 29.1 | 30.4 | 31.7 | 32.9 | 34.1 | 35.3 |
| 17,000 | 221 | 19.9 | 21.4 | 22.8 | 24.2 | 25.6 | 27.0 | 28.3 | 29.6 | 30.8 | 32.0 | 33.2 | 34.4 |
| 18,000 | 219 | 19.2 | 20.7 | 22.1 | 23.5 | 24.8 | 26.2 | 27.5 | 28.7 | 30.0 | 31.2 | 32.4 | 33.5 |
| 19,000 | 216 | 18.6 | 20.1 | 21.5 | 22.8 | 24.2 | 25.5 | 26.8 | 28.0 | 29.2 | 30.5 | 31.6 | 32.8 |
| 20,000 | 214 | 18.1 | 19.5 | 20.9 | 22.2 | 23.5 | 24.8 | 26.1 | 27.3 | 28.5 | 29.7 | 30.9 | 32.0 |
| 21,000 | 212 | 17.5 | 18.9 | 20.3 | 21.6 | 22.9 | 24.2 | 25.4 | 26.7 | 27.8 | 29.0 | 30.2 | 31.3 |
| 22,000 | 210 | 17.0 | 18.4 | 19.7 | 21.1 | 22.3 | 23.6 | 24.8 | 26.1 | 27.2 | 28.4 | 29.6 | 30.7 |
| 23,000 | 208 | 16.5 | 17.8 | 19.2 | 20.5 | 21.8 | 23.0 | 24.2 | 25.5 | 26.6 | 27.8 | 28.9 | 30.0 |
| 24,000 | 205 | 16.1 | 17.4 | 18.7 | 20.0 | 21.3 | 22.5 | 23.7 | 24.9 | 26.1 | 27.2 | 28.3 | 29.4 |
| 25,000 | 203 | 15.7 | 17.0 | 18.3 | 19.5 | 20.8 | 22.0 | 23.2 | 24.4 | 25.5 | 26.7 | 27.8 | 28.9 |
| 26,000 | 200 | 15.3 | 16.5 | 17.8 | 19.0 | 20.2 | 21.5 | 22.7 | 23.8 | 25.0 | 26.2 | 27.2 | 28.3 |
| 27,000 | 198 | 14.9 | 16.2 | 17.4 | 18.6 | 19.8 | 21.1 | 22.2 | 23.4 | 24.5 | 25.6 | 26.8 | 27.8 |
| 28,000 | 195 | 14.5 | 15.8 | 17.0 | 18.3 | 19.4 | 20.7 | 21.8 | 22.9 | 24.1 | 25.2 | 26.3 | 27.3 |
| 29,000 | 193 | 14.1 | 15.4 | 16.6 | 17.8 | 19.0 | 20.2 | 21.4 | 22.5 | 23.6 | 24.7 | 25.8 | 26.8 |
| 30,000 | 190 | 13.8 | 15.1 | 16.3 | 17.5 | 18.6 | 19.8 | 21.0 | 22.1 | 23.2 | 24.3 | 25.4 | 26.4 |
| 31,000 | 190 | 13.4 | 14.6 | 15.8 | 17.0 | 18.2 | 19.3 | 20.5 | 21.6 | 22.7 | 23.7 | 24.8 | 25.9 |
| 32,000 | 190 | 13.0 | 14.2 | 15.4 | 16.5 | 17.7 | 18.8 | 20.0 | 21.1 | 22.2 | 23.3 | 24.4 | 25.4 |
| 33,000 | 190 | 12.5 | 13.7 | 14.9 | 16.1 | 17.2 | 18.4 | 19.5 | 20.6 | 21.7 | 22.8 | 23.8 | 24.9 |
| 34,000 | 190 | 12.2 | 13.3 | 14.5 | 15.7 | 16.8 | 18.0 | 19.1 | 20.2 | 21.3 | 22.3 | 23.4 | 24.4 |
| 35,000 | 190 | 11.8 | 12.9 | 14.1 | 15.2 | 16.4 | 17.5 | 18.6 | 19.7 | 20.8 | 21.8 | 22.9 | 23.9 |



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BOMB, G.P., 500-LB., AN-M43

TABLE OF DROPPING ANGLE IN DEGREES

FOR OPERATIONAL AIR SPEEDS OF B-29 AIRPLANE

| ALT. FEET | IAS | GROUND SPEED - MILES PER HOUR | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 270 | 280 | 290 | 300 | 310 | 320 | 330 | 340 | 350 | 360 | 370 | 380 |
| 5,000 | 243 | 53.8 | 54.9 | 55.8 | 56.8 | 57.7 | 58.5 | 59.3 | 60.1 | 60.8 | 61.5 | 62.2 | 62.9 |
| 6,000 | 241 | 51.2 | 52.3 | 53.3 | 54.2 | 55.2 | 56.0 | 56.9 | 57.7 | 58.5 | 59.2 | 59.9 | 60.6 |
| 7,000 | 240 | 48.9 | 50.0 | 51.0 | 52.0 | 53.0 | 53.9 | 54.8 | 55.6 | 56.4 | 57.2 | 57.9 | 58.6 |
| 8,000 | 238 | 46.9 | 48.0 | 49.1 | 50.1 | 51.0 | 52.0 | 52.9 | 53.7 | 54.6 | 55.4 | 56.1 | 56.9 |
| 9,000 | 236 | 45.1 | 46.2 | 47.3 | 48.3 | 49.3 | 50.3 | 51.2 | 52.0 | 52.9 | 53.7 | 54.5 | 55.2 |
| 10,000 | 235 | 43.5 | 44.6 | 45.7 | 46.7 | 47.7 | 48.7 | 49.6 | 50.5 | 51.4 | 52.2 | 53.0 | 53.8 |
| 11,000 | 233 | 42.1 | 43.2 | 44.3 | 45.3 | 46.3 | 47.3 | 48.2 | 49.1 | 50.0 | 50.8 | 51.6 | 52.4 |
| 12,000 | 231 | 40.7 | 41.9 | 42.9 | 44.0 | 45.0 | 46.0 | 46.9 | 47.8 | 48.7 | 49.6 | 50.4 | 51.2 |
| 13,000 | 229 | 39.5 | 40.6 | 41.7 | 42.8 | 43.8 | 44.7 | 45.7 | 46.6 | 47.5 | 48.4 | 49.2 | 50.0 |
| 14,000 | 227 | 38.4 | 39.5 | 40.6 | 41.6 | 42.6 | 43.7 | 44.6 | 45.5 | 46.4 | 47.3 | 48.1 | 48.9 |
| 15,000 | 225 | 37.4 | 38.5 | 39.6 | 40.6 | 41.6 | 42.6 | 43.6 | 44.5 | 45.4 | 46.2 | 47.1 | 47.9 |
| 16,000 | 223 | 36.4 | 37.5 | 38.6 | 39.6 | 40.6 | 41.6 | 42.6 | 43.5 | 44.4 | 45.3 | 46.1 | 46.9 |
| 17,000 | 221 | 35.5 | 36.6 | 37.7 | 38.7 | 39.7 | 40.7 | 41.7 | 42.6 | 43.5 | 44.4 | 45.2 | 46.0 |
| 18,000 | 219 | 34.6 | 35.8 | 36.8 | 37.9 | 38.9 | 39.8 | 40.8 | 41.7 | 42.6 | 43.5 | 44.3 | 45.[illegible] |
| 19,000 | 216 | 33.9 | 35.0 | 36.0 | 37.1 | 38.1 | 39.0 | 40.0 | 40.9 | 41.8 | 42.7 | 43.5 | 44.[illegible] |
| 20,000 | 214 | 33.1 | 34.2 | 35.3 | 36.3 | 37.3 | 38.3 | 39.2 | 40.2 | 41.1 | 41.9 | 42.8 | 43.6 |
| 21,000 | 212 | 32.4 | 33.5 | 34.5 | 35.6 | 36.6 | 37.5 | 38.5 | 39.4 | 40.3 | 41.2 | 42.0 | 42.9 |
| 22,000 | 210 | 31.8 | 32.8 | 33.9 | 34.9 | 35.9 | 36.9 | 37.8 | 38.7 | 39.6 | 40.5 | 41.3 | 42.2 |
| 23,000 | 208 | 31.1 | 32.2 | 33.2 | 34.2 | 35.2 | 36.2 | 37.1 | 38.1 | 38.9 | 39.8 | 40.7 | 41.5 |
| 24,000 | 205 | 30.5 | 31.6 | 32.6 | 33.6 | 34.6 | 35.6 | 36.5 | 37.4 | 38.3 | 39.2 | 40.0 | 40.9 |
| 25,000 | 203 | 30.0 | 31.0 | 32.0 | 33.1 | 34.0 | 35.0 | 35.9 | 36.8 | 37.7 | 38.6 | 39.5 | 40.3 |
| 26,000 | 200 | 29.4 | 30.5 | 31.5 | 32.5 | 33.4 | 34.4 | 35.3 | 36.2 | 37.1 | 38.0 | 38.9 | 39.7 |
| 27,000 | 198 | 28.9 | 29.9 | 31.0 | 31.9 | 32.9 | 33.9 | 34.8 | 35.7 | 36.6 | 37.5 | 38.3 | 39.1 |
| 28,000 | 195 | 28.4 | 29.4 | 30.5 | 31.4 | 32.4 | 33.3 | 34.3 | 35.2 | 36.1 | 36.9 | 37.8 | 38.6 |
| 29,000 | 193 | 27.9 | 28.9 | 29.9 | 30.9 | 31.9 | 32.8 | 33.7 | 34.6 | 35.6 | 36.4 | 37.3 | 38.1 |
| 30,000 | 190 | 27.5 | 28.5 | 29.5 | 30.5 | 31.4 | 32.4 | 33.3 | 34.2 | 35.1 | 35.9 | 36.8 | 37.6 |
| 31,000 | 190 | 26.9 | 27.9 | 28.9 | 29.9 | 30.9 | 31.8 | 32.7 | 33.6 | 34.5 | 35.4 | 36.2 | 37.1 |
| 32,000 | 190 | 26.4 | 27.4 | 28.4 | 29.4 | 30.4 | 31.3 | 32.2 | 33.1 | 34.0 | 34.9 | 35.7 | 36.6 |
| 33,000 | 190 | 25.9 | 26.9 | 27.9 | 28.9 | 29.8 | 30.8 | 31.7 | 32.6 | 33.5 | 34.3 | 35.2 | 36.0 |
| 34,000 | 190 | 25.5 | 26.5 | 27.4 | 28.4 | 29.4 | 30.3 | 31.2 | 32.1 | 33.0 | 33.9 | 34.7 | 35.6 |
| 35,000 | 190 | 25.0 | 26.0 | 26.9 | 27.9 | 28.9 | 29.8 | 30.7 | 31.6 | 32.5 | 33.4 | 34.2 | 35.1 |

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C O N F I D E N T I A L

BOMB, G.P., 500-LB., AN-M43

TABLE OF DROPPING ANGLE IN DEGREES

FOR OPERATIONAL AIR SPEEDS OF B-29 AIRPLANE

| ALT. FEET | IAS | GROUND SPEED - MILES PER HOUR | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 390 | 400 | 410 | 420 | 430 | 440 | 450 | 460 | 470 | 480 | 490 | 500 |
| 5,000 | 243 | 63.5 | 64.1 | 64.6 | 65.2 | 65.7 | 66.2 | 66.7 | 67.1 | 67.6 | 68.0 | 68.4 | 68.8 |
| 6,000 | 241 | 61.3 | 61.9 | 62.5 | 63.1 | 63.6 | 64.2 | 64.7 | 65.2 | 65.7 | 66.1 | 66.6 | 67.0 |
| 7,000 | 240 | 59.3 | 60.0 | 60.6 | 61.2 | 61.8 | 62.3 | 62.9 | 63.4 | 63.9 | 64.4 | 64.9 | 65.3 |
| 8,000 | 238 | 57.6 | 58.3 | 58.9 | 59.5 | 60.2 | 60.7 | 61.3 | 61.8 | 62.4 | 62.9 | 63.4 | 63.8 |
| 9,000 | 236 | 56.0 | 56.7 | 57.3 | 58.0 | 58.6 | 59.2 | 59.8 | 60.4 | 60.9 | 61.4 | 62.0 | 62.5 |
| 10,000 | 235 | 54.5 | 55.2 | 55.9 | 56.6 | 57.2 | 57.8 | 58.5 | 59.0 | 59.6 | 60.1 | 60.7 | 61.2 |
| 11,000 | 233 | 53.2 | 53.9 | 54.6 | 55.3 | 56.0 | 56.6 | 57.2 | 57.8 | 58.4 | 58.9 | 59.5 | 60.0 |
| 12,000 | 231 | 51.9 | 52.7 | 53.4 | 54.1 | 54.8 | 55.4 | 56.0 | 56.6 | 57.2 | 57.8 | 58.3 | 58.9 |
| 13,000 | 229 | 50.8 | 51.5 | 52.2 | 52.9 | 53.6 | 54.3 | 54.9 | 55.5 | 56.2 | 56.7 | 57.3 | 57.8 |
| 14,000 | 227 | 49.7 | 50.5 | 51.2 | 51.9 | 52.6 | 53.2 | 53.9 | 54.5 | 55.1 | 55.7 | 56.3 | 56.9 |
| 15,000 | 225 | 48.7 | 49.4 | 50.2 | 50.9 | 51.6 | 52.3 | 52.9 | 53.6 | 54.2 | 54.8 | 55.4 | 56.0 |
| 16,000 | 223 | 47.7 | 48.5 | 49.2 | 50.0 | 50.7 | 51.4 | 52.0 | 52.7 | 53.3 | 53.9 | 54.5 | 55.1 |
| 17,000 | 221 | 46.8 | 47.6 | 48.4 | 49.1 | 49.8 | 50.5 | 51.2 | 51.8 | 52.5 | 53.1 | 53.7 | 54.2 |
| 18,000 | 219 | 46.0 | 46.7 | 47.5 | 48.2 | 48.9 | 49.6 | 50.3 | 51.0 | 51.6 | 52.2 | 52.9 | 53.4 |
| 19,000 | 216 | 45.2 | 46.0 | 46.7 | 47.5 | 48.2 | 48.9 | 49.6 | 50.2 | 50.9 | 51.5 | 52.1 | 52.7 |
| 20,000 | 214 | 44.4 | 45.2 | 46.0 | 46.7 | 47.4 | 48.1 | 48.8 | 49.5 | 50.1 | 50.8 | 51.4 | 52.0 |
| 21,000 | 212 | 43.7 | 44.4 | 45.2 | 46.0 | 46.7 | 47.4 | 48.1 | 48.8 | 49.4 | 50.1 | 50.7 | 51.3 |
| 22,000 | 210 | 43.0 | 43.8 | 44.6 | 45.3 | 46.0 | 46.7 | 47.4 | 48.1 | 48.8 | 49.4 | 50.0 | 50.6 |
| 23,000 | 208 | 42.3 | 43.1 | 43.9 | 44.6 | 45.4 | 46.1 | 46.8 | 47.5 | 48.1 | 48.8 | 49.4 | 50.0 |
| 24,000 | 205 | 41.7 | 42.5 | 43.3 | 44.0 | 44.7 | 45.5 | 46.2 | 46.8 | 47.5 | 48.1 | 48.8 | 49.4 |
| 25,000 | 203 | 41.1 | 41.9 | 42.7 | 43.4 | 44.2 | 44.9 | 45.6 | 46.3 | 46.9 | 47.6 | 48.2 | 48.8 |
| 26,000 | 200 | 40.5 | 41.3 | 42.1 | 42.8 | 43.6 | 44.3 | 45.0 | 45.7 | 46.3 | 47.0 | 47.6 | 48.3 |
| 27,000 | 198 | 40.0 | 40.8 | 41.5 | 42.3 | 43.0 | 43.7 | 44.4 | 45.1 | 45.8 | 46.5 | 47.1 | 47.7 |
| 28,000 | 195 | 39.5 | 40.2 | 41.0 | 41.8 | 42.5 | 43.2 | 43.9 | 44.6 | 45.3 | 46.0 | 46.6 | 47.2 |
| 29,000 | 193 | 38.9 | 39.7 | 40.5 | 41.3 | 42.0 | 42.7 | 43.4 | 44.1 | 44.8 | 45.4 | 46.1 | 46.7 |
| 30,000 | 190 | 38.4 | 39.2 | 40.0 | 40.8 | 41.5 | 42.2 | 42.9 | 43.6 | 44.3 | 45.0 | 45.6 | 46.2 |
| 31,000 | 190 | 37.9 | 38.7 | 39.5 | 40.2 | 41.0 | 41.7 | 42.4 | 43.1 | 43.8 | 44.4 | 45.1 | 45.7 |
| 32,000 | 190 | 37.4 | 38.2 | 38.9 | 39.7 | 40.5 | 41.2 | 41.9 | 42.6 | 43.3 | 44.0 | 44.6 | 45.2 |
| 33,000 | 190 | 36.8 | 37.6 | 38.4 | 39.2 | 39.9 | 40.7 | 41.4 | 42.1 | 42.8 | 43.4 | 44.1 | 44.7 |
| 34,000 | 190 | 36.4 | 37.2 | 38.0 | 38.7 | 39.5 | 40.2 | 40.9 | 41.6 | 42.3 | 43.0 | 43.6 | 44.3 |
| 35,000 | 190 | 35.9 | 36.7 | 37.5 | 38.2 | 39.0 | 39.7 | 40.4 | 41.1 | 41.8 | 42.5 | 43.2 | 43.8 |

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TARGETS AND TARGET DAMAGE



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of
The Commanding General
Army Air Forces
16 Dec 44 RLS
Date Initials

16 December 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Critique of J.T.G. Memo title, "Attacks on Urban Areas".

1. Summary. Recommendations are as follows:

Daylight Formation Attack on Nagoya:

| | |
|---|---|
| J.T.G. | M 18 Clusters of M69 IB |
| L.A.B. | M 18 Clusters of M69 IB |

20-30 Plane Attacks:

| | |
|---|---|
| J.T.G. | 4000# LC (or 500# GP) and M17 clusters of M50 IB |
| L.A.B. | 20% M26 clusters of M41 frags and 80% M18 clusters of M69 IB |

Single Plane Attacks:

| | |
|---|---|
| J.T.G. | 4000# LC and M17 clusters of M50 IB |
| L.A.B. | Test program, see Section 5. |

2. J.T.G. has done a thorough and commendable job in spite of the short time allowed. In general I concur in the suggestions made; where I differ it is usually in a specific detail. The value of regular nightly attacks on Tokyo is indisputable as is that of an occasional heavier one.

3. The J.T.G. recommendation regarding the daylight formation attack on Nagoya is entirely sound. Since neither the "butterfly" nor the M69X is available, I agree with the choice of 100% M69 IB.

4. When 20 or more ships are available for night attacks J.T.G. recommends aiming at industrial sections near the water front and using the 4000# LC plus M17 clusters of M50 IB. This is not a bad choice for such targets; if GP bombs are used direct hits must be scored in order to accomplish appreciable damage whereas much damage will result from near misses with the large blast bomb. The M50 has greater penetrative ability than the M69 and therefore is preferred for industrial targets. It happens that no 4000# LC are available at XXX Bomber Command bases, though a small quantity has been authorized for shipment within the past week.

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Therefore, until such time as they arrive I suggest a loading of 80% IB and 20% Frag. If the target is to be industrial areas the M50 should be used, if residential areas are to be attached, the M69--each in aimable clusters. The best frag bomb is the M83 (Butterfly) in M29 clusters, the fuzing of the bombs to be mixed: some with varying delays and some with anti-disturbance. However, this bomb is not available now at XXI Bomber Command bases either. Accordingly the M50 (With 20 to 30% M50X) is recommended for the industrial sections and the M69 (80%, plus 20% M26 clusters of AN-M41A1 20# frags) when residential areas are attacked. It is realized that the frag bombs and IB from the same ship are likely not to fall together but with this many ships the attack will spread over some time and the frags from later ships should prove useful in harassing the fire patrols fighting the earlier fires. Industrial targets are preferable unless they are too narrowly strung out along the water's edge. In that event too much of the bomb load will be lost in the water. To prevent this the aiming point should be chosen at least 3000 feet from the water front. If this results in aiming at a predominatly residential area the M69 is recommended. If a well defined aiming point is chosen it is possible that a sufficiently high density will be built up that a conflagration will result.

5. For the nightly attacks by two or three ships flying singly J.T.C. recommends the 4000# LC plus M17 clusters of M50 IB, to be directed primarily against the industrial sections, with an occasional one against the residential areas. Here I neither agree nor disagree. I visualize this type of operation as ideal to conduct a controlled test program to determine the effectiveness of the various weapons against Japanese residential areas. It is not certain that the M69 will be more effective than the M50 nor that either will be more effective than the 4000# LC, on a sortie basis. But it should not be difficult to find out. Therefore the following program is suggested:

a. Fly photo-reconn. missions on each clear day.

b. During the period between two successful photo missions (preferably about a week) drop only M69 IB on the nightly attacks. No frags are recommended as it is unlikely that the 20# frags will fall together with the M69 IB dropped from the same ship and unless they do their usefulness disappears, they only displace their weight of IB.

c. During the next such period drop only M50 IB. Twenty to thirty percent M50X bombs should be used. In fact a reasonable case could be made for dropping all small IB with anti-personnel device; this being a means of assuring the IB that hits in streets, paved courts, etc., at least a chance to do something useful (interfering with fire fighters moving through the streets, etc.). The argument against this is that some incendiary material would necessarily have to be sacrificed, and the primary job of IB is to start fires.







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d. During another period drop only 4000# IC.

e. Do not schedule a heavy attack against the area during a test period; it might overlap previous damage that had not been photographed and thus invalidate the test.

This plan should provide valuable data, not only for weapon analysis but for analyses of accuracy, radar, etc. If successful it could be extended to test the IB attack using 100% X-bombs, and the whole program might be tried against industrial areas.

LE ROY A. BROWNS
Operations Analyst
Twentieth Air Force

APPROVED:

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force

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SAVE

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By authority of
The Commanding General
Army Air Forces
3 Jan 45 RLS
Date Initials

3 January 1945

A NOTE FOR THE INFORMATION OF:
COLONEL CECIL E. COMBS, TWENTIETH AIR FORCE

Subject: "Effectiveness of Incendiaries on Nagoya".

1. Information desired for Analysis of XXI Bomber Command Strike against Nagoya Urban Area:

a. Number and size of formations airborne.

b. All strike photographs.

c. Reconnaissance photos (Preraid, Postraid) at least 24".

d. For each aiming point:

(1) Location of aiming point.

(2) Number of formations.

(3) Number of ships in each formation.

(4) Bomb load released by each formation.

(5) Time and altitude of release.

e. Bombs and fuzing used.

f. Altitude of cluster opening.

g. Wind and Weather data:

(1) Wind direction and speed at surface (for time of attack) (If necessary compute geostrophic wind from isobals and give "free air" wind speed).

(2) Wind distribution for every 5000 feet, surface to bombing altitude (for time of attack).

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(3) All information available for the preceding 5 days on:

(a) Number of sunshine hours
(b) Relative humidity
(c) Amounts of rainfall
(d) Temperature.

) If not available, give type of airmass present each day.

(4) Also for time of attack:

(a) Cloudiness

(b) Visibility

(5) Brief description of synoptic situation over target for 5 days previous to attack, up to and including time of attack.

ROBERT L. STEARNS, Chief,
Operations Analysis Division
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

3 November 1944

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Disease Rates after Tokyo Earthquake of 1923.

1. Following up my recent memorandum regarding the possible influence of disease on absenteeism after catastrophies in Japan, I checked into the Annual Health Reports of the Sanitary Bureau of the Home Department of the Imperial Japanese Government, published in Tokyo.

2. The published data for some of the diseases are very revealing.

a. For Typhoid Fever, the following figures are given for the city of Tokyo:

| YEAR | Cases Per 10,000 Inhabitants |
|---|---|
| 1921 | 13.2 |
| 1922 | 14.0 |
| 1923 | 18.9 |
| 1924 | 24.1 |
| 1925 | 12.6 |
| 1926 | 11.4 |

The earthquake took place on 1 September 1923, and already the figures for 1923 show a marked increase. In 1924 the cases reach a maximum of almost twice the figure for the years just preceding and just following these years affected by the earthquake. The Japanese Health Report makes specific reference to "the result of the unhealthy life after the great earthquake in Tokyo and Kanagawa prefectures."

b. A similar picture is shown by the death rates in Tokyo from Dysenterie, another disease badly affected by general sanitary conditions:

| Year | Death Rate Per 10,000 Inhabitants |
|---|---|
| 1920 | 0.85 |
| 1921 | 0.79 |
| 1922 | 0.87 |
| 1923 | 1.55 |
| 1924 | 1.14 |
| 1925 | 0.75 |
| 1926 | |

Again, about a doubling of the figure for 1923 is shown compared to the first completely normal year after the earthquake (1926).

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3. Influenza was not prevalent during and after the earthquake because September is still during the Japanese warm season (mean September temperature around Tokyo is about 72 degrees F.) However, the effect of cold weather on influenza is quoted in the Health Reports for the two important influenza epidemics of 1918-1919 and 1919-1920. In the first epidemic, slightly over twenty-one million cases of influenza were observed in all of Japan; a rate of three hundred and seventy cases per one thousand inhabitants. The city of Tokyo had 1,400,000 cases, or 389 cases per 1,000 inhabitants. During the epidemic of 1919-1920, 2,400,000 cases occurred in Japan (41 cases per 1,000 inhabitants) of which 432,000 were in the city of Tokyo. In 1920 the correlation to cold weather is quite evident. In all of Japan, January 1920 had 1,333,000 cases; February 582,000 cases; March 159,000 cases. The Reports comment, "The virus became furious as the weather became gradually colder and sufferers of the diseases of the respiratory system increased."

4. If an influenza epidemic is started as a result of a saturation attack upon the big cities, absenteeism in industrial plants can be expected to soar. To put sick persons on jobs would even contribute to further spread of the disease. In England during the epidemic of the end of 1943, absenteeism for cases of influenza ranged from four to eight days. Undernourishment in Japan should add to the receptiveness of people to the disease. Specific mention was made in recent press reports on how the physical hardening program of the Japanese Military Government for the civilian population back-fired last year. People couldn't take it, and disease rates went up when people were sent last winter to the mountain areas for training in physical endurance.

DR. M. E. LANDSBERG
Special Consultant.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

3 November 1944

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Possible Additional Influence of Temperatures on Casualty Figures in Attacks on Japanese Cities.

1. The report entitled "Economic Effects of Successful Area Attacks on Six Japanese Cities" has been reviewed.

2. An additional factor with respect to casualties and absenteeism may be worth considering. That is the effect of low temperatures on re-housing. This may influence the timing of the attack with respect to season. A table of appropriate figures for three of the target cities is attached.

3. It is contended that the casualty rate will be increased if the attacks are made during the cold season. If warm weather is prevalent, refugees from the attack prior to re-housing will be able to camp outdoors for a few days without deleterious effects on health. On the other hand, if the attack is carried on during the cold season, people can stay in the open only at the cost of grave risks to life and health, hence further casualties can be expected because of exposure. Respiratory diseases are likely to increase and, with hospitals likely to be taxed to capacity due to injuries, caused by the attacks themselves, serious epidemics may result. This factor will definitely tend to increase absenteeism in industrial plants.

| TOKYO | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean daily minimum temperature, degrees F | 29 | 30 | 34 | 44 | 54 | 62 | 69 | 71 | 65 | 54 | 41 | 32 |
| Mean number of days when temperature falls below freezing | 23 | 17 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 19 |

(Note also that number of clear days, good for visual bombing, has a maximum at Tokyo in December and January with ten to eleven days per month.)

| KOBE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean daily minimum temperature, degrees F | 34 | 34 | 39 | 48 | 56 | 64 | 72 | 74 | 69 | 58 | 48 | 39 |
| Mean number of days when temperature falls below freezing | 12 | 12 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

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NAGOYA

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean daily minimum temperature, degrees F | 20 | 21 | 25 | 45 | 54 | 62 | 71 | 72 | 66 | 52 | 41 | 34 |
| Mean number of days when temperature falls below freezing | 24 | 21 | 14 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 14 |

H. E. LANDSBERG
Special Consultant

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OPERATIONS ANALYSIS REPORT

Issuing Unit: Operations Analysis Division
Twentieth Air Force

Title: TARGET ANALYSIS AND RELATED STUDIES

Date: 13 March 1945

Identification: Report dated 13 March 1945

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Note: Operations Analysis Sections (designated in some theaters as Operational Research Sections ) have been established in a number of Air Force Commands pursuant to a memorandum from CG AAF to All Air Force Commanders, dated 24 October 1942, approving this activity.

This is a report of one such Section. Information as to Operations Analysis Sections and Reports can be obtained from Operations Analysis Division, Management Control, Headquarters, Army Air Forces, Washington, D.C.

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13 March 1945

# TARGET ANALYSIS AND RELATED STUDIES


## Summary

The importance of target analysis in modern aerial bombardment is perhaps better understood than are the detailed steps required in such analysis. Accordingly the phases of the analysis of an industrial target, together with other studies related to it, are listed (Section I 1 and 2). The importance of each phase, its relation to the others and the information and personnel required are discussed. The studies are grouped for maximum efficiency of production and a geographical location for the performance of each group is suggested.


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## I. Target Analyses and Related Studies

1. Analyses and Studies Related to Targets. The following analyses are required for each virgin target:

a. Structural analysis.

b. Functional analysis

c. Strategic evaluation

d. Weapon recommendation

e. Weapon selection and force requirements

Following the attack further studies are required:

f. Damage assessment (physical damage)

(1) Flash assessment (from strike photos)

(2) Preliminary assessment (from reconnaissance photos)

(3) Detailed assessment (using all available photos and information)



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g. Re-evaluation of target

(1) Preliminary (based upon prelim. dam. assess.)

(2) Detailed (based upon detailed dam. assess.)

For each re-attack of a target that has been re-evaluated the following are necessary:

h. Weapon recommendation, as in d above

i. Weapon selection and force requirements, as in e above.

j. Damage assessments (1), (2), (3) as in f above.

k. Re-evaluation of target (1), (2) as in g above.

Certain special studies directly related to targets and contributing materially to effective bombing are:

l. Bombing accuracy.

m. Weapon analysis.

2. Analysis of Target Systems. Somewhat similar analyses are required for target systems. Using the above listed reports for all of the targets in a system as part of the data the following studies are required for each system:

n. Evaluation

o. Weapons

p. Force requirements

q. Running evaluation

In succeeding paragraphs each of the analyses and studies listed in sections 1 and 2 will be discussed together with its importance, its relation to the others, and information and personnel needed for its successful completion.

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3. Structural Analysis of the Virgin Target. The first step in the analysis of a target is to learn all that can be learned about the construction of the individual buildings and installations making up the target. This information facilitates the functional analysis since industrial buildings are designed to house the particular function to be performed. Thus it may be determined with reasonable certainty that particular buildings do not have height sufficient to house equipment for lifting and handling heavy parts, or a plant may have no building with spans sufficiently wide to assemble large aircraft.

The structure of the target also governs partially the choice of bomb and fuze; if many of the buildings have concrete roof slabs the fuzes should be set to explode the bombs just beneath the roof, to break up the heavy slab and drop it on the contents of the building. If the target has large hangars with wide-span arched roofs a large bomb fuzed to explode just under the roof may sever one or more arches and possibly collapse a large part of the roof structure. When a large part of the target consists of combustible buildings a part of the load should be IB.

The principal source of information useful in structural analysis is reconnaissance photography. Clear, large scale (not less than 1:8000) photos are best and should be obtained several weeks before the attack, if possible, to allow ample time for careful analysis. All other available intelligence should be used also; examples: old target material based on pre-war intelligence, insurance company records (many industries in enemy and enemy occupied territory insured with American and British companies), ground photos. Highly skilled interpreters are required; structural or architectural engineers familiar with industrial buildings are best suited for this work.

4. Functional Analysis. The probable function of each building and installation in the target area must be determined or assumed. The probable flow of production through the plant may then be estimated, allowing choice of primary and secondary objectives. Buildings housing functions vital to the operation of the plant will weight the selection of weapon and influence the choice of aiming point. Building function facilitates estimation of probable contents, whether or not they are inflammable, etc.

The information needed for functional analysis is a structural analysis ( in as great detail as possible) and as much material relating to the industry as possible. Photographs, descriptions of buildings, equipment and plants, interviews with people from the same industry in friendly territory, perhaps visits to such plants, are all helpful. Men who have built or operated similar plants are best suited for the functional analysis.

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5. Strategic Evaluation. Evaluation of the production output of the target plant is necessary for the duel purpose of assigning priority to the target in the target system and of furnishing a yardstick against which to measure the effectiveness of the attack. The production estimates for individual plants also serve as data for evaluation of the industry as a whole.

Evaluation of production (sometimes termed economic analysis) is made with the aid of the structural and functional analyses together with all other available intelligence. Data relating floor space to production and relative size of the various components of the plant to production are needed, along with many other. Name plate data, captured documents, POW interrogation material, interviews with citizens of Allied countries who are familiar with the actual enemy target; these are some of the sources of material. Economists, plant engineers and managers are the men best equipped for the evaluation of the targets.

6. Weapon Recommendation. The choice of the correct weapon for a target is second in importance only to accurate and efficient delivery of the bombs to the target. It is perfectly possible for one weapon to be less than half as effective as another against a particular target. If the less effective one is used it will require more than double the force to accomplish the desired damage. What is more likely is that the target will require many extra attacks before it is knocked out thus increasing the cost in men, aircraft and materiel.

The structural and functional analyses are helpful in the choice of bomb and fuze. The more known regarding both buildings and their contents the better the selection is likely to be. Bomb size, type and fuzing are governed by the dimensions and construction of the buildings and the nature of their contents. The amount and type of IB largely depend upon the degree of combustibility of both buildings and contents. Actually the recommendation is based upon a somewhat lengthy calculation in which a weighted average of the buildings and other installations of the target "selects" the weapon or weapons.

For this part of the work men well acquainted with industrial structures and their contents and with what bombs will do to them are needed. Engineers who have designed or built industrial structures or who have operated the plants and who have thoroughly acquainted themselves with effects of bombs on such installations are well suited for the job. They must be kept abreast of all developments in weapons and should have all available data on weapon effectiveness. The combination of a fire insurance engineer and a Chemical Warfare officer is ideal for the IB part of the study.



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7. Weapon Selection and Force Requirements. Operational conditions existing at the bases on the day of the attack sometimes dictate that the weapon actually selected cannot be the one recommended in the target analysis. Thus the actual selection of weapon and determination of force must be made at Bomber Command, usually by a committee representing Operations, Intelligence, Plans, Ordnance, Chemical Warfare and Operations Analysis.

An integral part of the calculation referred to in the preceding section is the determination of the number of hits required in the target area. This is often expressed as a bomb density, in such units as tons per acre, a quantity which often varies considerably for bombs of different size or type for the same target. Data from past experience is the best material for this determination but often is somewhat incomplete. Every effort is made to piece it out however with results of tests and with theoretical reasoning. A rigorous analysis of current attacks is essential, and ground surveys of targets following our invasion of enemy occupied territory furnish useful information.

Once the number of hits required is determined it is comparatively easy to translate this into tonnage and thence into the number of airplanes needed, provided data is available on the accuracy of the force and on its ratio of aircraft over the primary target to aircraft assigned to the mission. These two quantities are constantly changing, generally improving, so that current figures must be available.

8. Damage Assessments. Once the target is hit the damage must be assessed and the target re-evaluated. The damage assessment is done, normally, in three stages or phases with increasing detail and accuracy. A fourth phase assessment, necessary in certain cases, will be discussed under Weapon Analysis, Section 12. The first, or flash, assessment is made from strike photos and because the target becomes partially obscured by the smoke and dust of the attack almost immediately this assessment is not very detailed. Actually, an earlier estimate of possible results based upon the visual observations of the crews is usually made but is generally subject to inaccuracy.

The second assessment is also a quick, tentative one and is made as soon as reconnaissance photos are available. This one consists of an annotated photograph and a tabulation of the buildings damaged giving the extent of the damage. Both first and second phase assessments are of physical damage only and serve a triple purpose: to furnish a tentative measure of the



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success of the attack, a quick estimate of the re-attack date for the target, and a decision whether or not the damage warrants a third phase assessment and re-evaluation.

The third phase assessment, also of physical damage, is made using both strike photos and reconnaissance photos. Immediate pre-attack and post-attack cover are needed for this purpose, the day before and the day following the attack if possible. It is essential to know exactly what the target was like when it was attacked (especially important in areas in which more than one attacking force are operating). Post-attack cover even a few days late is unsatisfactory; craters are filled, debris is cleared, etc. Strike photos often reveal bomb-hits and other detail not clearly shown in reconnaissance cover.

The areas of damage should be carefully determined and appropriately marked to distinguish between fire damage and HE damage where this is possible and between damage to the structural frame of the building and superficial damage to the roof covering. Also, serious internal damage without structural damage should be indicated where it exists, if possible.

Accurate interpretation of physical damage is difficult and requires a high degree of skill and patience. Architects and structural engineers do well at this but any skilled interpreter can learn to do a satisfactory job. However, to insure that the assessments from the several bomber commands are of a uniform and high standard there should be at least one especially trained interpreter in each P.I. unit. These men should have identical training and should be kept in constant contact with each other and with the central P.I. group doing fourth phase assessments* for weapon analysis, repair studies and the like. Perhaps rotation of these special interpreters among commands and between commands and the central unit would best accomplish this.

The damage plot thus made serves Bomber Command as a measure of the success of the attack, in selection of weapon, force and aiming point if the target is to be re-attacked, and for inclusion in its mission report. It may also be used directly in the economic re-evaluation of the target.

*Discussed under Weapon Analysis, Section 12.

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9. Re-evaluation of the Target. The determination of the new target-value following each attack is an obvious necessity. If, as occasionally happens, very little damage has been accomplished the re-evaluation consists merely of a glance at the first or second phase damage assessments. But it usually requires a rather detailed examination of the third phase damage assessment and the translation of areas of damage (in the several categories) into estimates of loss of production. Finally, the remaining production potential is compared with that of the other targets of the system in order to establish its priority for re-attack.

The material and personnel required for this work is the same as for the original evaluation.

10. Re-attack Analyses. For re-attack, once the re-evaluation has been made, it is necessary to make a new weapon recommendation study. For the undamaged portion of the target the weapon, or weapons, and fuzing required may be quite different from the original requirements. This is because the weapon actually used is generally a compromise weapon selected by a weighted average of the components of the target; with a portion of the target severely damaged the remainder may "select" a different weapon. The procedure and personnel required will be the same as for the original weapon recommendation.

The actual selection of weapon and determination of the force required will be made in exactly the same manner as before.

Damage assessment and re-evaluation will also proceed much as before. It should be noted though that immediate pre-attack and post-attack cover should be provided here also if possible. This is particularly important for assessment of a re-attack in order that new damage can be clearly distinguished from old damage and possible repairs, demolition or new construction can be accounted for. Personnel requirements here are the same as for original damage assessments and evaluations.

11. Bombing Accuracy. The contributions of analysis of accuracy to the success of strategic bombing are well known. The effects of size and shape of formations, altitude, intervalometer setting, dropping on the leader, etc. on the size, shape, aiming accuracy and density of the bomb pattern have been fairly well established. Data from such studies often suggest possible improvements that can be made and are essential for the force requirements computation.

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Required for bombing accuracy studies are information regarding bombs and fuzes used, aircraft loading, formations, ballistics, abortives, etc. From these and strike photos (beginning at bombs-away and photographing the bombs down at short intervals until they strike) a bomb plot is made. This plot should show the pattern from each formation and its relation to the assigned aiming point, and a table giving the number of bombs dropped over the primary target, the number and percent identified, and the percent within 1000 feet, 2000 feet, etc. of the aiming point.

The analysis of the bomb-fall lends itself naturally to a scientific approach and it was demonstrated early that statistical theory could be accurately and profitably employed. Accordingly mathematicians and statisticians have done well in this work. It is essential that they be equipped to translate their findings into understandable and usable form.

12. Weapon Analysis. Until recently weapon analysis, the determination of the effectiveness of our weapons from analyses of our attacks on enemy targets, has not been adequately exploited. As a result relatively little reliable data on the effectiveness of our weapons exists. However, the need for this data is realized now and procedures have been established which undoubtedly will fill this need soon.

The structural and functional analyses together with the economic evaluation furnish the information regarding the target; a detailed damage assessment and production loss study give the effect of the attack. To insure the consistency in the damage plots essential for reliable weapon analyses fourth phase damage assessments, all made to the same standard and of a high standard, are required. To expect the requisite consistency among assessments made by interpreters in widely separated P.I units would be unrealistic. For this reason a small P.I. unit consisting of men skilled and experienced in this work is needed to serve the unit making the weapon analyses. They would assess only the attacks for which weapon analyses were being made.

It remains to relate the damage to the weapon causing it. This requires a more comprehensive bomb plot than that described above, in that the HE pattern must be distinguished from the IB pattern. Until recently weapon analysis was attempted from post-attack cover alone but it is clear that the only reliable means of determining the bomb density (especially of small IB) on the target is to photograph the bombs down. The crater of the small IB cannot be distinguished and it is rare that its burst can be seen. Therefore the clusters must be photographed from bombs-away until they open and the bombs disappear from sight. If this is done a combination of the principles of photogrammetry and ballistics can locate the pattern on the ground with reasonable accuracy.



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Economy of personnel and elimination of duplication of effort dictate that a single bomb plot should be prepared to serve for both bombing accuracy and weapon analysis. All available photography (strike and post-attack) and other information and material should be used in preparing such a plot and it should be drawn accurately on a plot of the target so that it can be seen clearly which buildings are overlapped by the HE pattern, the IB pattern, or both.

This bomb plot can be prepared by any skilled interpreter but the work should be supervised by an experienced photogrammetrist.

13. Analysis of Target Systems. From the evaluations of the individual targets in a system the total contribution of the system to the enemy's war economy is obtained. This evaluation together with the estimated timing of the effect on the front line fighting of an interruption to production governs the priority of the system of targets.

A summation of the weapon selection and force requirements studies for all of the targets in a system makes possible a fairly accurate schedule of procurement of munitions.

Finally, as a system of targets is under attack a running evaluation of its production loss is kept for comparison with its potential production if unattacked.

The finished reports from the analysis of the individual targets together with other intelligence from all possible sources furnish the material for these overall studies. The men who make these analyses need not be specialists but rather must have intellectual stature, good analytical judgment, and an appreciation of the interplay between the components of a national war economy. Evaluation reports of this kind are required by Headquarters AAF, the Chief of Naval Operations and the Joint Chiefs of Staff.

II. Geographical Location of the Work

14. The Logical Grouping of the Studies. The target analyses and related studies fall naturally into three groupings which, due to the character of their source material and to the purpose to be served by the studies, require different geographical locations for efficiency of production and effective use. Some should be made at Bomber Command, others at Theater Air Headquarters and the rest at USAAF Headquarters in Washington. The



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assumption is made here that a central headquarters will be set up from which all aerial bombardment in the Theater will be directed.* This is the headquarters which is referred to herein as "Theater Air Headquarters."

15. Bomber Command. The following studies should be performed at Bomber Command (reference is to sections I, 1 and 2 of this paper):

e. Weapon selection and force requirements.

f. Damage assessment (physical damage)

(1) Flash (1st phase)

(2) Prelim (2nd phase)

(3) Detailed (3rd phase)

i. Weapon selection and force requirements for re-attacks.

j. Damage assessments following re-attack.

l. Bombing accuracy (including a bomb plot satisfactory for weapon analysis).

There is no better place for these types of work to be performed than at Bomber Command. This is true because all of the operational data, photos and information needed are available first at Bomber Command. Attempts to do some of it in Washington result in great delay at best and often the report has to be finished on incomplete data. Furthermore, due to Bomber Command's own urgent need for them the studies will be made there; so that if they are made anywhere else duplication of effort cannot be avoided.

This work can be done at Bomber Command by the Photo Tech Unit with the guidance and help of the Operations Analysis Section. This might require the addition of one or two specialists to the Operations Analysis Section.

16. Theater Air Headquarters. At Theater Air Headquarters the following studies should be made:

Pre-attack:

a. Structural analysis.

*It is anticipated that units of one or more service branches of several Allied Nations may participate.



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b. Functional analysis.

c. Strategic evaluation

d. Weapon recommendation

Following attack:

g. Re-evaluation of target

(1) Preliminary (based upon prelim. dam. assess.)

(2) Detailed (based upon detailed dam. assess.)

h. Weapon recommendation for re-attack.

k. Re-evaluation of target (following re-attack).

n. Weapon analysis.

Theater Air Headquarters is suggested for this part of the work since these analyses will be of interest to and concerned with the operations of all the bombardment forces in the Theater. There must be close liaison between the people doing this work at Theater Air Headquarters and all Bomber Commands, Naval forces or other units attacking the targets. These studies will necessarily depend upon those made at Bomber Command and there should be free intercourse between the analysts at the several headquarters. In fact it would be an excellent thing if the personnel could be rotated between Bomber Commands and Theater Air Headquarters at intervals of, say, six months.

It must be noted that the performance of this work in the Theater will require building up a Target Group of considerable size and transporting a large body of intelligence material to the Theater. But the alternative, doing the work in Washington, is bound to sap a large measure of its vitality before it is completed. The gain far outweighs the cost of doing it in the Theater.

17. USAAF Headquarters, Washington. The analysis of target systems, to be done in Washington:

n. Evaluation

o. Weapons

p. Force requirements

q. Running evaluation



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Since these analyses are closely tied to the overall planning of the air war and require access to all of the most secret intelligence there is little doubt but that Washington is the logical place for their production. A small Evaluation Section would therefore be required in Washington. In addition a small group of technical men would be needed to process the material from the Theater and feed it to the evaluation analysts. They would also make such long term analyses as would be required, back-stop the Theater organization, and maintain contact with ETO and with research organizations such as AAF Board, Ballistics Research Laboratory, National Defense Research Committee, U. S. Strategic Bombing Survey and the British Ministry of Home Security.

LEROY A. BROTHERS
Operations Analyst

APPROVED:

ROBERT L. STEARNS, Chief,
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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

WNT/clw

25 November 1944

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Need for Improved Radar Navigational Procedure.

1. The most serious defect in the radar bombing missions of XX Bomber Command to date is believed to be the lack of navigational teamwork incorporating into DR navigation the use of radar information. It is believed that sound DR navigation is, if possible, even more important on radar bombing missions than on visual missions. On radar missions, however, the tendency to resort to radar pilotage rather than DR seems particularly strong. Radar pilotage appears so easy, particularly in coastal regions, that this temptation is hard to avoid and the radar operator tends to be confident that DR is not required. Just as in visual pilotage, however, it is easy to make mistakes and one island, one inlet, or one peninsula may look very much like another. Many missions in different operating theaters appear to have been sacrificed through failure of radar pilotage, and even when no mistakes are made the approach to the target may be widely different from the briefed course so that the pick up of the aiming point and the carrying through of the bombing operation cannot be performed in accordance with the planning and briefing. It is believed that most of the gross errors in radar bombing, that is errors of more than 1 or 2 miles, have resulted either from failure of radar pilotage, or from the substitution of relatively inaccurate pilotage for DR navigation in the target approach.

2. It is believed that the Nagaski mission of August 10, No. 6 of XX Bomber Command, is an example of the failure of radar pilotage, The target is perfect from the radar standpoint, not only being the entire urban area, and consequently amply large, but also being in a coastal region where an ideal response pattern should have been obtained from land-water boundaries. Good results were reported by the returning crews, but later, photo reconnaissance showed no damage whatever in the target area. The presumption that radar pilotage was resorted to and that the mission failure resulted from wrongly-identified responses is made very strong by comments on the navigation appearing in the mission critique. Instrument conditions prevailed and the navigators relied largely on radar. On comparing the logs of different ships, however, there was no agreement between the found winds, so even the crudest DR navigation could not have been practiced. Further training of the radar operators on wind finding was recommended in the critique. No only was the wrong area bombed but two ships were lost on the return voyage as a result of faulty navigation. (This seems clear from contacts made by the lost ships with the Aircraft Control Center in the forward region on the return). Many other aircraft, which did return to base, required large numbers of QDM's.

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3. A problem of this kind, as it appears to involve merely the question of a shift of emphasis in training and in operations, is most difficult to attack effectively. Although the need for good DR in connection with the use of radar equipment has been frequently pointed out and seems to be generally recognized, much more than this is necessary to assure any substantial improvement. The problem needs to be reviewed at a high level and appropriate and thoroughgoing measures taken in connection both with the training program in this country and with procedures used in the operating theaters. Some suggested measures are as follows:

a. It should be insured that in the radar navigator training program DR navigation is made the dominant consideration and that procedures involving specific equipment should be subordinated to it and taught in relation to it.

b. Provision should be made for increased training of newly formed aircrews in the teamwork of radar-DR navigation in this country before leaving for theaters of operation. Practice is desirable in keeping DR plots on simulated operational missions on which only radar data are employed.

4. It should be pointed out that this problem of achieving effective radar-DR navigation is not only important in present operations involving AN/APQ-13 equipment, but will be even more crucial when AN/APQ-7 comes into use. This new equipment provides increased definition so that less difficulty should be experienced in identifying the aiming point within the response of the target area. The narrow sector of scan, however, renders pilotage extremely difficult. The argument has been made that the increased resolution will insure the identification of those responses that come within the field of view, but this is most unconvincing in view of pilotage failures with present equipment in favorable regions where the definition is quite adequate. Also, British experience with low-resolution and high-resolution $H_2S$ clearly shows a greater tendency to gross errors with the latter. It is urged most strongly that only the greatest effort to achieve good DR navigation with its aid can prevent navigational failures from destroying the potential effectiveness of the AN/APQ-7 equipment.

W. N. TUTTLE,
Operations Analyst.

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

11 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Selection of (Lead) Crew Members

1. Early in this year I wrote, while at Headquarters Second Air Force, several notes on the principles of crew selection. Two main considerations were:

a. That crew performance involves interactional behavior.

b. That the behavior, and specifically the interactional behavior, of different individuals is affected to differing degrees when the partial pressure of oxygen respired is reduced; such differential effects can be detected with equivalent elevation to as little as 8,000 feet (and probably at equivalent 5,000 feet). In the B-29 airplane conspicuously, the significance of interactional behavior is obvious; the interaction of Pilot, Co-Pilot, Flight Engineer; the interaction of Navigator, Bombardier, Radar Operator; the interaction of the Ring Sight Gunner and the Waist Gunners and the Tail Gunner; of the Pilot and Tail Gunner Observer in the lead plane in formations - all are obvious examples. The problem of the lead crew is of special significance - within the framework of a functional job analysis, it should ideally be not only good, but the best available for lead purposes, in its group. The capacity for smooth, effective interaction is a major condition for maximum effectiveness. It is not true that the abstractly most skillful, practiced Pilot will be the most effective Pilot under combat conditions in a given B-29 crew combination. Of course, sufficiently long association of crew members will certainly serve to weed out unadjustable members, but the factor of inter-crew loyalty will often work to "cover up" for an inefficient but well-liked member (as I know from acquaintance with actual instances, in training).

2. The question in my mind has been whether advantage should not be taken of the technics rather recently developed for the objective evaluation of a given subject's capacity for smooth interactional behavior, and of his capacity to adjust his interactional behavior to that of other individuals in changing situations. This field has been very strikingly and, I think, successfully developed by Dr. E. D. Chapple. Its utility has been strongly supported by results of tests with Navy pilots before training as compared with the prediction as to whether they would successfully complete training and receive Wings, comparison with the evaluations of the combat performance of the pilots in terms of the estimates of their proficiency, are just now in process of being made.

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3. Ideally, at least, the role of simulated altitude in these tests and estimates has not been overlooked; and it has been examined experimentally, Ideally, likewise, the role of emotional pressure could also be estimated. For example, I have had very definite reservations about the significance of camera gunnery scores for the evaluation of gunners in training: the excitement of actual combat will (up to a point) inevitably increase the precision of neuromuscular adjustments, as I know from studies in my own Laboratory - beyond that point, if active fear is induced it may decrease them - but in any case simulated combat (let alone dead target shooting) is not the behavioral equivalent of a combat mission. Remotely in a practical sense, but none-the-less in an important way, this line of thought may help to explain why I distrust the results of routine psychological examination (as at present practiced) of candidates for Lead Crews. The tests in use for crew candidates, broadly speaking, have been "blind" - with small apriori justification, with very small validification as yet by comparison with quality of combat performance, and with no attention whatever to interactional capacities of individuals in a crew situation.

4. If the considerations developed at a recent conference at Fort Worth on the training of gun crews for B-29, as units, are effectively developed, a real step in advance will have been made. For various reasons (and I speak as one who was present at the Fort Worth conference) one must have reservations - and certainly I do not say this in criticism of any of the authorities responsible for the formulation or the execution of the program there devised. But this is not a specific solution to the problem of selecting lead crews. A Lead Crew should have members of individual technical competence, of course, the higher the better. But they should also have exceptional capacity to execute coordinated activity under pressure. My suggestion is in brief, that:

a. In default of any other criterion, and

b. Because of the weight of experimental evidence behind its theoretical worth, an opportunity be given to apply the simple tests of interactional behavior, in terms of the "job" situation in the B-29 airplane, to the selection of Lead Crews.

5. Dr. Chapple was in Washington today, and I took the occasion to have him talk with Dr. Gettell and myself. He has had a good deal of down-to-earth experience with similar problems in the field of industrial relations. He has agreed to think about this general question - that is, with reference to Lead Crews. Several Practical questions obtrude:

a. In terms of actual practice missions, what are the interactions of crew members in the natural performance of their functions? I was able to suggest that a Clovis Dr. Moore has taken records of "intercom" and direct voice communication during flights. These could be studied to advantage for preliminary purposes. The point is that the Manuals, S.O.P.'s and the like, tell what should and must be done



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by each man. But the other, frequently the decisive factor, lies in the frequency - the time spacing - of the interlocking actions. In other words, a conventional "job analysis" covers only part of the relevant ground.

b. Would a productive study of the kind suggested consume too much time?

(1) Is this sort of thing going to "slop over" into the AC-92 kind of job? I think not; go on what has been done already and reach a decision; the actual testing would not take too much time.

(2) Would the Air Surgeon's Office object? Possibly. Major Ward, in Air Surgeon's Office at Headquarters Second Air Force, would not, I believe; it is true that the functional conceptions implicit in this kind of examination are, on the whole, foreign to the entire notion of psychological testing as practiced in this country.

c. Could effective tests be made in time to be of war significance? I believe that they could. Naturally, this depends on an estimate of the duration of the war against Japan; I do not believe that this will be brief.

d. Of great significance, as Dr. Gettell was quick to point out - Will Field Commanders accept the Lead Crews suggested by any testing or recommending agency? Probably not in all cases - and it should not be implied that they should. The whole tenor of opinion among those who think in terms of functional analysis would be quite opposed to any such conception. The group Commander must exercise responsibility in a given situation. The contention here is simply that, statistically speaking, the "best" Lead Crew will definitely, give better over-all bombing results; that any "correction" in the direction of establishing in advance a probable criterion for "best" is better than no "correction" at all. It is surely not beyond the scope of possibility that even a tough-minded group of officers could be lead to see the point. This might be a major missionary job, but with the proper approach, some progress could be made, I am sure. At least, the possibility should not be neglected, and I suggest that Dr. Chapple be seen by you at an early date.

W. J. CROZIER
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

15 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Test Flights Under Poor Weather Conditions in B-29.

1. During my recent visit to the Hq. Second Air Force several discussions were devoted to the problem of bad weather flight training. Upon a suggestion of Dr. Kaplan a memorandum covering this subject was prepared, copy of which is attached.

2. Col. Benaker, Director of VHB training of Second Air Force, was very much interested in this problem. He and one of his assistants, Major Colburn, felt that some test flights with a B-29 in bad weather should also be conducted in the Second Air Force for the purpose of obtaining data for a bad-weather flying training-aid pamphlet for B-29 pilots. Information now available from the manufacturer and others is rather inadequate. Only theoretical data seem to be available on the behavior of the B-29 under severe icing conditions and conditions of severe turbulence. They would like to do some flying under bad weather conditions, using the long flying experience of Major Colburn in commercial airlines and in B-29's. They tried to obtain the use of a B-29 for about a month for this purpose from OC & R on their recent visit to Washington but were told to use their training ships. They felt that with the present Flight Training Program they could not afford to divert any of their planes to this purpose. They thought that there are planes at Wright Field that did not find sufficient practical use and that in view of field and training problems bad weather flying should be given more attention. They expressed hope that Twentieth Air Force Headquarters might give them some help to attain their purpose. I would like to indorse this strongly because I feel any experience on bad weather flying infiltrated into the training program will pay large dividends in combat operations.

3. With respect to such bad weather flying training I understood from the plans division of the Second Air Force that future plans call for the putting of the B-29 Bases into the good weather belt of the Second Air Force area. If this tendency is followed the crews will receive less bad weather training than ever heretofore. This policy, while probably enabling the Second Air Force to maintain training schedules better and reduce their accident rate, seems undesirable because it will throw additional strain on the commands in the theater.

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Not only will these have to condition their crews to flying under combat conditions but simultaneously to bad weather flying, if exigencies of war plans demand flying in such weather. However, learning to fly blind or through storms, etc., can just as well be learned here at home and, instead of less flying under these conditions more of it should be given here at home. It seems better to accept a perhaps higher accident rate at an earlier stage of development than to throw this on the theater where losses are apt to have more serious effect on the progress of the war.

4. It is suggested that Twentieth Air Force Headquarters for selfish reasons:

a. Support the request of the Second Air Force to get and use for a limited period of time a B-29 for bad weather flying tests.

b. Urge the Second Air Force to increase the amount of bad weather flight training for crews now in training there.

It is felt that experience such gained will benefit the operations of the Commands in the field.

H. E. LANDSBERG,
Operations Analyst
OAD, Twentieth Air Force.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

NOTE FOR INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS SECTION, SECOND AIR FORCE

Subject: Training of B-29 Pilots and Navigators in Bad Weather Flying.

1. Analysis of the combat mission reports of the XX Bomber Command as well as a preliminary check of B-29 accidents involving weather in domestic and foreign theaters indicates that the experience level of pilots and navigators in flying through bad weather conditions is rather low. Often poor weather conditions are superimposed upon other factors, such as engine failures, malfunction of electrical equipment etc. Experience of commerical airlines and of combat crews in the European theater show that experienced pilots and navigators can handle such troubles even under bad weather conditions because they know how to fly bad weather. In many of the B-29 cases of accidents and non-combat operational losses, however, airplanes have been lost because bad weather flying is not second nature to the key crew members. Getting "lost" and hence running out of gas and finally abandoning the airplane altogether occurs too often as yet.

2. Poor weather conditions, when encountered in nature, generally are not just one kind of weather trouble in each instance but frequently involves combinations of several of the following conditions:

a. Instrument weather.

b. Turbulence (may lead in addition to structural failures).

c. Precipitation static (may lead in addition to radio equipment failures).

d. Icing.

In frontal thunderstorms, for example, all of these conditions may be encountered simultaneously. The natural consequence of inexperience with flying through these conditions is tenseness on the part of the key crew members and psychologically that state may readily lead to "pilot errors" especially if troubles "snow-ball".

3. It should therefore be seriously considered to give more real bad weather training to B-29 crews. One factor that stands out from the reports on cases when weather troubles lead to undesired consequences, is that instrument flying experience of pilots in the last six (6) months preceding

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accidents, for example, is of the order of magnitude from ten (10) to forty (40) hours. Compared to airline pilot experience this is very little. Quite a bit of this experience, moreover, has not been gained in actual bad weather but under simulated conditions such as hoods, etc., with an instructor pilot next to the pilot. Of course, knowing that another man can take over as soon as any mistake is made by the student pilot, leads the latter to relax and hence his psychological state is not the same as if he were actually encountering bad weather with nobody around to help him if he should get into a tight spot.

4. A planned program could be set up to take advantage of relatively poor but not inherently dangerous weather situations to help the pilot to gather more experience in dealing with adverse weather conditions. For example, at times a stratus layer or altostratus layer of 2000 or 3000 feet thickness may exist at sufficient altitude to enable contact flight. If, for training purposes, the flight plan would call, however, for instrument flight in the cloud layer, the pilot could gain real blind flying experiences. Yet, if anything goes wrong or he should get lost, he can go below the cloud level and continue his flight a contact. Simultaneously, of course, navigators could gain more instrument experience.

5. In addition certain type of ground training by the use of appropriate films could be given. This could, for example, comprise pilotage training by showing film reels show actual pictures of terrain as seen from the air and comparing these with such navigational charts as are available. Cooperating with field units such films could show terrain as encountered in actual flight on a combat mission, such as from B-29 Chinese bases to Japanese territory. An advanced step would be to cut out certain portions of the film corresponding to time intervals (one, two or more hours) flown on instruments and letting pilots and navigators locate their position on charts from portion of film when contact pilotage is possible again.

6. Also navigators (according to the field reports) could use more training in wind and drift determinations, use of D method of navigation etc.

7. While such a program may initially lead to some complications and even certain operational losses in training, it undoubtedly will pay off in dividends later by cutting down losses due to inexperience in bad weather flying in later stages of the training program, during transit and in the theater of operations.

H. E. LANDSBERG
Operations Analyst
Twentieth Air Force





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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By Authority of
The Commanding General
Army Air Forces
19 Dec 44 RLS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

19 December 1944

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: VLR Weather Reconnaissance.

1. You know that I have been very much interested from the beginning of my connections with the Twentieth Air Force in the development of Weather Reconnaissance. The experiences in Western Europe and the Mediterranean have convinced, I believe, all weather people that adequate weather reconnaissance should be an integral part of all combat operations, especially strategic bombing. In order to be effective the weather reconnaissance has to be carried out by airplanes of the same range as that of the combat planes that participate in the missions. Also, these planes should be equipped with appropriate airborne weather reconnaissance instruments and have officer specialists in weather reconnaissance aboard. A weather reconnaissance officer is not the same as a weather officer, who is essentially trained as forecaster.

2. Already last August it was recommended that each Bomber Command of the Twentieth Air Force should have a B-29 weather reconnaissance squadron. General Ent to whom these ideas were presented at the time fully agreed that this was necessary and Colonel Seaver, Staff Weather Officer of the XXI Bomber Command before going overseas tried to obtain such a squadron for his command.

3. On my recent trip to Colorado Springs, a member of OAS Training Branch told me of some rumors that a B-29 Weather Reconnaissance Squadron was to be activated. I got in touch with with Colonel Mc Neal, who is in charge of Weather Training in AC/AS Training, in order to track down the rumors. He had not heard of any plan for a B-29 Weather Recon. Squadron. However, crews are to be trained for F-11 reconnaissance planes. Altogether, the requirement is for 52 weather reconn. officers, who are to be pilots, radar and photo reconnaissance officers at the same time. This plan foresees activation of a flight of four (4) airplanes by 1 July 1945, a squadron of twenty-four (24) airplanes by 1 September 1945, and a squadron of twenty-four (24) by 1 December 1945. After initial training at various schools these are to be sent for crew training to one of the training Air Forces. They referred me for further information to Major H. E. Miller in OC & R.

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4. Major Miller gave me some additional points. The F-11 is still in the very early stages of development and will probably not be available before the middle of 1945. It will then have to be found out if the ship is adaptable to reconnaissance work. Since it is a two-engine plane training of the crews will probably take place in the Third Air Force. Major Miller's office in OC & R feels that B-29's should be used for Weather Reconnaissance but they have not made a corresponding recommendation because they feel that they could not get by with it. Reason for this is that they were turned down flat when they tried to obtain a flight (4 ships) of B-29's for Radar Reconnaissance. They think the only way to get ships especially equipped and with crews trained for weather reconnaissance is by request from the theater.

5. It is obvious that the XXI Bomber Command is flying Weather Reconnaissance with combat ships and crews. This seems to be a makeshift arrangement forced by necessities. My own opinion is that it will only become fully effective if equipment and personnel is up to the task and that ultimately, as in the other theaters, full fledged weather reconnaissance will be the answer to the problem.

6. If VIR weather reconnaissance squadrons are activated, whether in the Second or Third Air Force, a carefully designed crew training program will have to be designed and the OAS of these Air Forces may have to help devising this through their respective training branches. They will also need a good ground weather section to monitor the flight reports from the training crews. We may eventually be able to help them in setting up a good program.

7. This is for your information. You may want to pass some points on to Colonel Combs.

H. E. LANDSBERG
Operations Analyst,
OAD, Twentieth Air Force

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By authority of
The Commanding General
Army Air Forces
2 Jan 45 RAS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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2 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: The Need for Adequate Weather Reconnaissance for the Twentieth Air Force.

Table of Contents:

1. Weather and Bombing Results.
2. Forecast Errors.
3. The Answer - Weather Reconnaissance.
4. Weather Reconnaissance for the Twentieth Air Force
5. Conclusions, Recommendations and Anticipated Results.

1. Weather and Bombing Results:

a. Basis for this report are the mission reports of the XX Bomber Command. Between 5 June and 27 November 1944, the XX Bomber Command flew, among others, 2 combat missions each against Bangkok, Anshan and Omura. One of the missions against each target encountered good weather over the target, the other poor weather. The results achieved on these missions were analysed. They enable one to show the effect of target weather on present bombing accuracy. The mission pairs chosen were numbers 1 and 18 (Bangkok), 4 and 9 (Ashan), 13 and 16 (Omura).

b. A complete tabulation of comparable numerical data for each pair of missions appear in table II at the end (of paragraph 1) of this report, The results of the analysis can briefly be summarized as follows:

Table I:

| Three Missions Each: | Bad Target Weather: | Good Target Weather: |
|---|---|---|
| Total No. A/C over Target | 179 | 174 |
| % of A/C Airborne at forward bases | 59 | 84 |
| Mean cloud cover below A/C at primary Target | 9/10 | 1/10 |
| % of identified bomb hits within 3000 feet of aiming point | less than 1 | 80 |
| Total of No. A/C. lost on missions (Regardless of cause) | | |

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Three Missions Each:

| | Bad Target Weather: | Good Target Weather: |
|---|---|---|
| Total No. of A/C damaged on missions (Regardless of cause) | 28 | 32 |
| Total No. of casualties on missions | 80 | 43 |
| Mean Consumption of gasoline per A/C bombing primary, in gals. | 6222 | 6031 |

c. Superficially viewed the data given in Table I indicate that when poor weather prevailed over the target:

(1) With the same number of aircraft over the target bombing results achieved were 79% poorer,

(2) Less aircraft of those dispatched reached the primary target*,

(3) Loss of aircraft and casualties were higher,

(4) Gasoline consumption was 3½% higher (200 gallons per A/C per strike),

than in cases when good target weather prevailed.

More strictly interpreted the above given data show that with poor weather over the target the efforts were wasted, if one considers that the purpose of a combat mission is to put the bombs on the target. In the three poor weather missions, with negligible bombing results,

10 airplanes (B-29) were lost.
28 airplanes (B-29) were damaged.
80 highly trained men became casualties.
2663 bombs were scattered and over 1.2 millions gallons of gasoline were burned in vain.

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* Numerical comparison is not possible because in case of mission number 16 part of the effort was re-directed after take-off because of a forecast revision, but many A/C failed to receive the message. In the other two pairs of missions at least 10% more airplanes reached the target in good weather than in bad weather.



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TABLE II

| Mission Number | Date | Target | Type Bombing | Cloudiness Below A/C Obs. | Cloudiness Forecast | A/C Airborne | A/C Bombing Primary | % of Airborne % Bombing Pri. | #A/C Lost | #A/C Damaged |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 June 44 | Bangkok | Radar | 7-10/10 | 3-6/10 | 98 | 77 | 79 | 5 | 3 |
| 18 | 27 Nov 44 | Bangkok | Visual | 0 | 2-4/10 | 60 | 55 | 92 | 0 | 12 |
| 9 | 26 Sept 44 | Anshan | Mainly Radar | 8-10/10 | 4/10 | 105 | 73 | 69 | 0 | 15 |
| 4 | 29 July 44 | Anshan | Visual | 3/10 | 2-4/10 | 72 | 60 | 83 | 3 | 7 |
| 16 | 11 Nov 44 | Omura | Radar | 10/10 | 3/10 | 96 | 29* | 30 | 5 | 10 |
| 13 | 25 Oct 44 | Omura | Visual | 0 | 4/10 | 78 | 59 | 76 | 2 | 13 |

* Attempt was made to re-direct A/C after take-off when weather data indicated poorer target conditions than had been forecast, but many A/C failed to receive message.



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| Killed | Missing | Wounded | Bombs Dropped On Primary | #Bombs Identified 0-3000' From AP | % of bombs identified 0-3000' from AP | Mean Gas Consumption per A/C (gals). |
|---|---|---|---|---|---|---|
| 15 | 2 | 8 | 1472 | 18 | 1.2 | 6066 |
| 0 | 11 | 4 | 1529 | 1040 | 90.7 | 5265 |
| 1 | 0 | 2 | 731 | 0 | 0 | .6152 |
| 8 | 3 | 3 | 448 | 205 | 67 | 6067 |
| 2 | 47 | 3 | 456 | 0 | 0 | 6448 |
| 12 | 0 | 2 | 624 | 263 | 81 | 6760 |



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2. Forecast Errors:

a. Although the mission reports do not disclose in how far command decisions were influenced by the weather forecast, it is clearly indicated that in the three abortive missions approximately 4/10 cloudiness over the targets had been forecast but around 9/10 was encountered.

b. It would be easy to place the blame for these failures on the forecasters involved. However, even the best forecaster cannot be expected to make reliable forecasts with insufficient data. One of the most difficult forecasting problems is a pin-point forecast on cloudiness for a place over 1000 miles distant 24 or more hours in advance. The density of observing meteorological stations available to the forecasters in the Far Eastern area is much less than necessary for good forecasting. The number of available upper air observations (pilot balloons and radiosondes) are far below U.S. standards. Considerable areas in the Far East are blank spots on the weather maps, partly because of occupation by enemy forces, partly because from vast ocean areas only a few weather reports are available. Furthermore, forecasters in a theater of war are always plagued by communication and ciphering problems.

c. Lack of adequate data in conjunction with the present state of knowledge in meteorological science would make it unfair to place the blame for forecast failures in the theater of war on the weather service. Even in peace-time Far Eastern weather presents some of the toughest problems to the meteorologist. Even when more experience is gained by U. S. Weather personnel in the theater no radical improvement of forecasts can be expected in the near future, unless the forecasters are provided with much more comprehensive observational material than heretofore.

d. During many months of the year only a few clear days can be expected over the majority of Far Eastern targets. To forecast these days is a most important task in order to enable the commands to exploit to the fullest these occasions which will make pin-point bombing of strategic targets possible. For many months to come, even with the best available radar techniques, visual bombing will be necessary to achieve the destruction of pin-point targets with a minimum number of missions.

3. The Answer - Weather Reconnaissance:

a. The problems presented in paragraph 1 and 2 above are not new ones. They have been encountered before in air operations over Western Europe, in the Mediterranean and over the North Atlantic. The answer in all these cases - even though at times only reluctantly accepted - has been weather reconnaissance.

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b. Weather to the aviator is the same as terrain is to the infantry man. In unknown territory, terrain reconnaissance is always carried out in advance of ground operations. How much more is reconnaissance needed in the atmosphere which has no fixed features and where changes are so rapid in time and space?

c. That weather reconnaissance is effective has been proven, wherever the right kind of air planes in sufficient number, with proper equipment and specially trained personnel were provided for the purpose. Evidence to that affect is presented in an appendix to this report giving pertinent quotations from official publications.

d. At the time of this writing there is, e. g., a weather reconnaissance squadron in the North Atlantic, flying 6 fixed courses each day (3 from Iceland, 3 from the Azores). This squadron, flying about 1000 hours each month, delivers about 1400 observations per month to the forecasters. In Western Europe seven squadrons (RAF and USAAF), 2 of them from the Eighth Air Force fly daily reconnaissance missions over fixed courses from England, Ireland, Scotland, the Faroes and in addition weather target missions over enemy held territory. In the operational region of the 15th Air Force a weather reconnaissance squadron keeps a close check on the difficult alpine weather conditions and the weather over German targets beyond the mountain barrier. All this is found necessary, and extremely helpful, in spite of the fact that our knowledge of weather in Europe is far superior to most other regions of the world, that the station network for surface and upper air data is very dense and the the distances to be flown in combat rarely exceed 500 miles.

e. The Weather Reconnaissance procedure employs, aide by side, two techniques:

(1) The flying of fixes courses at regular hours.

(2) Spot checks of weather over targets.

From the view point of the forecaster the first type of reconnaissance is by far the most important and useful one. The data from these flights are received regularly and they improve weather analysis and forecasts materially. In Europe, for example, many important meteorological events, such as fronts, could have never been foreseen without these regular weather reconnaissance flights. The spot checks are helpful as a last minute forecast verification. If they are long before the contemplated target time they loose much of their effectiveness. Because of the irregularity of these flights in time and space they contribute relatively little to the improvement of forecasts.

4. Weather Reconnaissance for the Twentieth Air Force:

a. At present the XXI Bomber Command flies weather strike missions on as many nights as feasible. Plans call for the employment of the specially trained 655th Bomber Squadron (H) equipped with B-24's for weather reconnaissance in the Pacific area early in 1945.

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b. Any sort of weather reconnaissance is, of course, better than none but it should be realized at an early date that the procedure now in use or contemplated is far from fulfilling the needs. Compared to the North Atlantic and Europe much less is known about forecasting weather conditions over Far Eastern target areas. Therefore, weather reconnaissance should be flown in such a fashion as to enable the forecaster to achieve optimal success. If it is recognized that weather is a factor of prime importance in strategic bombing then it is clear that weather reconnaissance is coupled with other aims such as incidental bombing, photographic reconnaissance, radar reconnaissance, etc, it loses much of its effectiveness. These other aims are not compatible with the purpose of weather reconnaissance. The most important areas to be reconnoitered from a meteorological point of view are rarely the target areas which it is desirable to bomb or for which photographs or radar coverage are wanted. Also, weather reconnaissance by night by visual means, is only a very poor substitute for what is really needed. Weather reconnaissance reaches its maximum efficiency when a full complement of thoroughly trained observers are on the airplane and equipment for upper air data are installed. Finally, the planes used for weather reconnaissance should have the same or, preferably, a greater range than the distance of the missions to be flown.

c. The use of a squadron of B-24's, even if exclusively used for weather reconnaissance, in the Pacific area will from a meteorological point of view, be insufficient to solve the weather problems of the Twentieth Air Force.

(1) From the present bases the range of these planes is too small to furnish the necessary data. The old proverb applies here that one should not send out a boy to do a man's job.

(2) Even if advanced bases are secured which will bring the target area within striking distance of the B-24s, these planes will not be suitable for target weather reconnaissance in day time. Because they have to radio weather information back, in order to make it immediately useful, these planes can be tracked readily by enemy monitors. This will lead to interception and these planes are too slow to escape enemy fighters.

(3) Weather reconnaissance airplanes in order to be fully effective should be equipped to drop radiosondes at fixed intervals. Experiments with such equipment have been conducted but progress has been very slow. The needs of the Twentieth Air Force require that promising leads in this instrumental development be exploited rapidly and equipment be made available at the earliest possible date for Pacific weather reconnaissance.

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5. Conclusions, Recommendations and Anticipated Results:

a. The following conclusion can be drawn:

(1) On comparable combat missions the XX Bomber Command achieved no bombing results when weather conditions over the targets were poor.

(2) Because of inadequate weather data the pin-point target forecasts are poor. Adequate weather reconnaissance, as experience in other theaters of war shows, is the answer to the problem.

(3) The effort wasted on 3 resultless combat missions would have sufficed to run daily weather reconnaissance for the XX Bomber Command for a half year. The A/C losses suffered on these abortive missions would have constituted nearly a full weather reconnaissance squadron.

(4) The present and now contemplated weather reconnaissance for the Pacific area is inadequate.

b. The following recommendations are made:

(1) Each of the constituting Bomber Commands of the Twentieth Air Force should have a weather reconnaissance squadron of long-range, well defended, fast airplanes. (At present only B-29s are adequate for the job). These airplanes should be equipped with the latest meteorological equipment and manned with trained personnel to give maximum information to the weather service.

(2) Weather reconnaissance missions should be flown solely for weather purposes and be completely divorced from all other distracting duties. Most of the weather reconnaissance should be flown regularly on fixes courses selected by weather personnel for the purpose of filling in gaps in the existing weather information.

(3) The weather reconnaissance airplanes should be equipped to make radiosonde descents while in flight. The agencies concerned with developing and procuring the necessary equipment should be instructed to rush their experimental work to the point where such equipment can be delivered to the operating squadrons at the earliest possible moment.

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c. If the plan outlined in paragraph 5 b. above is followed, the following results can be anticipated:

(1) An improvement in the weather forecasts resulting in the reduction of abortive missions flown.

(2) Greater success in forecasting good weather over the targets leading to a maximum exploitation of such opportunities for strategic pin-point bombing.

H. E. LANDSBERG
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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APPENDIX

Excerpts from Article by Lt. John B. Blake, entitled, "North Atlantic Icing", in Weather Service Bulletin Vol. 2, No. 5, November 1944, p. 17.

The North Atlantic Wing of the Air Transport Command faced the responsibility of cargo and ferry operations across one of the world's more dangerous air routes in winter weather, long recognized as severe and treacherous.-- To promote safe operation, extensive weather reports were indispensable. Gaps between reporting stations on the North American mainland, on Greenland, Iceland, and on the British Isles had to be filled in by radio reports from weather reconnaissance aircraft which could investigate pertinent areas and levels. C-54 cargo planes were assigned to this duty, and teams of forecasters from the 8th Weather Squadron made the extensive observations required.

Excerpts from an Article by Captain E. E. Churchill, entitled, "Weather or Not", in Air Force, December 1944, pp 62-63.

Less than a year ago, unpredictable weather was costing the 15th Air Force an average of three or four abortive missions a week. Dozens of others were being grounded by the uncertainty of weather conditions en route and over the target. Precious time and gasoline was being squandered by flying three or four hours toward targets, only to find them overcast. Failure to utilize the maximum number of bombing days was giving the enemy an opportunity to put his factories back into operation before they could be paid encore visits.---Weather was at the root of these uncompleted missions, but weather forecasters were not to blame.---There had to be a practical solution to these problems. The 15th found it in weather reconnaissance.

In less than a week after the organization of the detachment, abortive missions had been practically erased. By the end of February, weather reconnaissance flights had been officially credited as the decisive factor in the success of 15 missions that otherwise would not have been attempted.---Missions flown by weather reconnaissance are roughly divisible into three principal categories. First, there are the general area mission. Second, Target check missions. Third, Pathfinding missions to locate openings.---The observation planes are most useful in making sure that time is not wasted in going to impossible targets, and that a clear target is not passed up.--Weather reconnaissance, one of the newest and most promising phases of strategic bombing, received its greatest tribute in a recent statement---with no strings attached---made by A-3 of 15th Air Force. It was that the operations of the reconnaissance unit had slashed at least six months from the length of the war in the Mediterranean by making it possible to carry out continuous bombing strikes.



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"German Weather Reconnaissance", from interview with German officer P/W
(15 November 1944)

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German Weather Reconnaissance:

a. A great deal of importance was attached by the German Meteorological Service to airplane ascents and meteorological reconnaissance. Not only were airplanes always made available by the High Command of the Luftwaffe for this purpose, but also the officers flying weather ascents and reconnaissance received high awards after completing a certain number of these flights.....

b. Many of the reconnaissance flights were long distance flight and fourmotored aircraft was regularly allocated to these flights. At times, even six motored long distance airplanes were allocated to the weather reconnaissance squadrons.of these long distance flights, theree were made regularly every day.....

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5 March 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AIR FORCE

Subject: The Effectiveness of Weather Strike Missions of the XXI Bomber Command

1. In the period from 6 December 1944 to 2 March 1945 the XXI Bomber Command had scheduled 250 weather strike missions. It seems appropriate to raise the questions:

a. How effective are these missions as weather reconnaissance?

b. How effective are these missions as strikes against enemy targets.

2. a. It is not quite clear which of the two objectives of the missions is of more importance in the mind of the commander. For the time being it has to be assumed that they are coordinate objectives and considered to be of equal importance.

b. It can be stated as axiomatic that weather reconnaissance is an integral part of all strategic bombardment operations. In the Pacific area it is an imperative necessity for the forecaster. Unfortunately no long range reconnaissance airplane is available that could adequately cover the areas from which information on weather conditions is desired.

c. The only airplane that, at the moment, has the range, speed and armament to undertake long range reconnaissance missions is the B-29 which is, of course, primarily a bombardment aircraft. The reluctance of a commander to use such aircraft for reconnaissance purposes only is readily understood. Hence, the coordination of reconnaissance with bombardment activities was decided upon.

3. a. The question whether the missions are useful as weather reconnaissance missions cannot be answered by statistical figures. There is no control element available. One has no way of telling whether the weather forecasts produced during the period, in which these missions were flown were better than forecasts that would not have had the benefit of the observations from these missions. It is reasonable to assume that they have contributed somewhat to the forecast accuracy. Yet it should be made absolutely clear that these missions do not constitute weather reconnaissance in the ordinary sense of the word.

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b. These missions were directed toward the same target areas as major combat operations. If weather information is desired for such large-scale missions, let us say, against eastern Honshu then a plane sent toward that area many hours before the main mission will not contribute very much toward the forecast. Weather reconnaissance has to be flown into the area where the weather comes from, where the frontal systems develop, and where critical pressure centers are located at the time. Such reconnaissance may occassionally take a weather reconnaissance airplane over an important target area but more often probably into territory where there is nothing to bomb. Any bomb load such a reconnaissance airplane is made to carry will decrease its range--and for weather reconnaissance the more range the better.

c. The amount of information on weather gathered on a weather strike mission with a regular combat airplane is small. The missions are often flown without special weather equipment, frequently without a trained weather reconnaissance officer on board, with personnel not thoroughly familiar with weather reconnaissance techniques, such as drift and pressure determinations with the absolute altimeter. In the beginning of February, during my visit to the AFPOA Weather Contral, after these flights had been going on for two months, not more than on an average of about half a dozen useful observations per flight were gathered--certainly a very small yield for the effort.

d. Granted that the information gathered was better than nothing, compared to normal use of the term they did not constitute weather reconnaissance. The flight may have had some incidental value as training flights for combat crews but then they should perhaps not be called weather missions.

4. a. There remains the second question to be answered: How effective are these missions as strike missions? The available statistics furnish clues to the answer. Of the 250 weather strike missions scheduled during the past three months 16 (6.4%) were cancelled for a variety of reasons. Hence 234 actual take-offs took place. All of these were directed toward the main Japanese Islands. Thirty (30) aircraft airborne on Weather Strike Missions aborted, mostly for reasons connected with mechanical failures, ile. 12.8% of the airborne aircraft. A mission was called abortive when it failed to reach the Japanese Islands. A good proportion of the 204 aircraft reaching the islands either did not bomb at all or did not bomb the intended target cities. Those, however, considering the fact that weather information was part of the purpose were not counted as abortive. The operational losses were relatively small with only 4 aircraft of those airborne (- 1.7%) having been lost.

b. Of the 204 aircraft reaching the Japanese Islands 32 failed to bomb any target (- 15.7%), of these 13 carried no bombs, 16 jettisoned their bombs for a variety of reasons and in 3 cases the reports simply stated that "no bombs were dropped". That means 172 aircraft

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dropped bombs on some target, or on what they thought to be a target, in the main Japanese Islands. The method of bombing and the results indicated by the crews in the reports are given in Table I, in numbers of sorties flown. The percentage in each category in terms of the total of 204 sorties reaching Japan is shown in parentheses.

TABLE I

| METHOD OF BOMBING | RESULTS OF BOMBING | | | | |
|---|---|---|---|---|---|
| | Totals | Good | Explosion Seen | Fires Seen | Bomb Bursts Seen | Unobserved |
| Visual | 51(25.0) | 6(3.0) | 2(1.0) | 16(7.8) | 8(3.9) | 19(9.3) |
| Radar | 104(51.0) | 4(2.0) | 3(1.5) | 22(10,8) | 17(8.3) | 58(28.9) |
| Navigation* | 17 (8.3) | 0(0) | 0(0) | 3(1.5) | 4(2.0) | 10(4.8) |

*Usually resorted to when radar was non-operative; bombs generally dropped at ETA over target.

c. It is, admittedly, difficult to assess the value of these bombings without the benefit of strike and damage photographs. As a first approximation one may be justified to use crew observations. This is likely to result in a rather optimistic assessment of the results. Therefore, all cases where the reports indicated good results, the fact that explosions (other than bomb bursts) had been seen or fires had been noted after the strikes, were considered as having achieved some result and may be termed useful. In that category are 56 sorties or 27.5% of the total number of aircraft reaching the general target area. On the other hand, cases when only bomb bursts were seen or results were unobserved are likely to have produced little impairment of the enemy's war potential. This assumption is particularly warranted because in a very large proportion of the cases (43.5% of the sorties) bombs were dropped by the present rather inaccurate radar method or the even less reliable navigational method.

d. If, instead of using sorties, the results are analyzed similarly as above in terms of bomb load dropped the following values emerge:

Total bomb load dropped on 204 sorties: 484.25 tons (= 2.36 tons per sorties)

Bomb load dropped for which some result was claimed: 163.8 tons (= 34% of the total load dropped or 31% of these carried to the targets)

A more complete breakdown yields the figures given in Table II, in tons with the figures in parentheses showing the percentage in terms of the total bomb load carried to the targets.

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TABLE II

| Method of Bombing | Totals | Results of Bombing: Good Explosion Seen | Fires Seen | Bomb Bursts Seen | Unobserved |
|---|---|---|---|---|---|
| Visual | 149.85(28.3) | 16.6(3.1) | 3.5(1.0) | 47.95(9.1) | 24.65(4.7) | 55.15(10.4) |
| Radar | 288.90(54.3) | 12.45(2.4) | 8.8(1.7) | 64.80(12.2) | 47.85(9.0) | 155.0(29.3) |
| Navigational | 45.50(8.6) | 0(0) | 0(0) | 8.7(1.6) | 8.25(1.6) | 28.55(5.4) |

In assessing the possible results of the "Visual" bomb runs, it should be borne in mind that these missions were flown at night.

e. It is probably not understated if one evaluates the results of the bombing by weather strike missions as "desultory", contributing only in a negligible fashion to the strategic bombing of the Japanese Islands. One major raid with about 180 aircraft (such as are now carried out) could deliver the same total bomb load carried on all weather strike missions. If such a raid were carried out in clear weather one might expect 60 per cent of the bombs to fall within 2000 feet of the aiming point, a figure twice attained by the XX Bomber Command on days with clear target weather. Hence, if real weather reconnaissance would contribute to forecast accuracy only to the extent of adding one day every three months to the number of missions flown in clear weather over the target all the bombs that could be dropped by aircraft now flying "weather strike missions" would be delivered and chances are that an important strategic target could be eliminated. No such result could ever be expected from the scattered bombing of the individual strikes. It does not seem over optimistic that real weather reconnaissance could improve forecasting to the extent of guaranteeing one more visual mission every three months.

f. There are certain incidental effects of the weather strike missions which should be mentioned such as the harrassing effect upon the enemy, etc. If experience in Europe is any guide, civilian populations usually get rapidly used to raids by single planes and rarely lose any sleep over them. In fact regular raids keep the defenses on their toes and improve fire fighting techniques because the small number of fires started by a single raider do not tax the facilities. So even as regards harassing weather strike missions are probably not very effective.

5. Conclusions are:

a. Weather strike missions can not take the place of regular weather reconnaissance. Their value to forecasting is relatively small.

b. The bomb load delivered by 234 aircraft dispatched on weather strike missions in three months equals only the quantity that could be dropped on a target by 180 aircraft in a major strike.

c. It is certain that weather forecasting could be sufficiently improved by regular weather reconnaissance so that one additional visual major mission could be flown every three months equalling the bomb load delivered by weather strike aircraft and probably yielding



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better results than the scattered strikes could.

6. Recommendations are:

a. Divorce weather reconnaissance completely from strike missions.

b. Establish daily regularly weather reconnaissance to the important "weather target" area with VLR aircraft, properly equipped and manned and exclusively used for this purpose.

R. E. LANDSBERG
Operations Analyst

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7 April 1945

Weather and Very Long Range Air Operations

Since no specific topics were assigned to me for discussion before this meeting, I thought it might perhaps be profitable to present some of the weather factors influencing VLR air operations. This presentation is less concerned with the strictly synoptic forecast problems rather than the operational problems involving weather. I shall try to point out some of the things where, by accurate forecasting the meteorologist can help to contribute to the success of operations.

The purpose of the VLR air force is to lay bombs on strategic enemy targets. This purpose is accomplished by VLR bombardment aircraft, at present essentially B-29s. Incidental to the protection of these bombers from enemy opposition will be VLR fighter operations. Both, VLR bomber and fighter operations against Japan from the bases presently occupied by our forces are at the limit of their respective range, that in the case of the bombers is compatible with a reasonable bombload. Present operations are high level and low level precision bombing of strategic pin-point targets and attacks on large industrial and urban areas which are important to the enemy's war potential. For all these purposes the target weather forecast is a most important planning element. This forecast is essentially a forecast of cloudiness at various levels for a small area for a specified short period of time, the target time, rarely exceeding one or two hours, 24 or more hours in advance. In a good many cases, command decisions are based on this particular phase of the overall operational weather forecast. Most desirable for nearly all purposes of strategic bombing are visual conditions. Generally, only cloud conditions of 3/10 or less total cloudiness below bombing altitude are unqualifiedly good for visual precision bombing. But not only the cloud amounts are of importance but also their heights because, if the tactical situation permits, an elevation can be sought at which cloudiness below is at a minimum. In order to let the strategic VLR air force accomplish its mission efficiently and expeditiously it is not only most desirable that forecasts calling for little or no cloudiness at the targets are correct, so that a task force that is sent out to exploit such weather conditions will find them verified, but it is equally important that all such situations are properly forecast. If on the basis of a forecast for considerable target cloudiness no mission is scheduled and it turns out that cloudiness would have been favorable for one, a valuable opportunity is missed and has to be made up for later, which means that the war is actually prolonged by such a failure.

The success of VLR aircraft to do accurate bombing from high altitudes is quite remarkable. On clear days, units of the Twentieth Air force have been able to deposit from high altitudes 60 percent of their bomb loads within 1000 feet of the aiming point. Targets attacked under such conditions have been effectively crippled, or even completely

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destroyed, in one single attack. On the other hand, with considerable cloudiness below the level of attack, necessitating the use of radar, bombing accuracy leaves much to be desired. Under those weather conditions many repeat performances over the same target are called for. Each operation, no matter wheather it offers opportunity for visual bombing or not, is potentially costly. Normally, one can expect to loss just as many men and aircraft, to expend as many bombs and gallons of gasoline for a radar mission as for a visual mission. The results, however, are, as pointed out before, spectacularly different. I would therefore call the target cloudiness forecast the most important single operational weather problem. Anything that can be done to improve that type of forecast will increase the effectiveness of the strategic air force and any effort toward that end seems worth considerable expenditure in manpower and funds.

For area attacks with incendiary bombs weather conditions other than cloudiness are of considerable importance for the scale of success achieved. A combination of low relative humidity, lack of rainfall in the period preceding and immediately succeeding the attack and high wind speeds at the surface are highly desirable for optimum results. If a choice of days favorable for such attacks can be made on the basis of weather forecasts, again a smaller number of missions will be required for the reduction of a target than if less favorable weather conditions prevail.

Last, but not least, the forecast of the wind vector at bombing altitude is of importance for planning the axis of attack, and this wind forecast in combination with good forecast for all levels down to the surface will make ballistic corrections possible that contribute to bombing accuracy.

It is, of course, essential for the achievement of the main purpose "bombs on the target" that the aircraft gets over the target with a minimum expenditure of fuel and then gets safely back to its base. Poor weather conditions en route requiring to burn excessive quantities of gasoline and preventing, for the daylight missions, the flying formation result in losses.

In ETO, in the past, airplanes that ran out of gasoline have had no other choice but ditch and with the understandable difficulties in Air - Sea rescue, there have been deplorable losses of life. Good forecasting can contribute greatly to the safety of the non-combat portions of the flight. It will especially help in navigation. It can be readily visualized that flights requiring a 3000 mile round trip strain the faculties of navigators to the limit. Under instrument weather conditions the task to arrive at the target is not easy. For radar missions it is very vital that navigation will bring the aircraft to the proper point on the enemy coast where it is possible to identify



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prominent radar responses that will help setting the plane on the blind bombing run. Anybody, even slightly acquainted with Japanese climatology, will readily realize that there are several months during the year when radar missions will have to be run in addition to visual ones, because the opportunities for visual missions are far below the operational capabilities of the Field Commands. On the return from long range missions, it is essential that the aircraft will find its base. The bases, as you know, are specks in a vast ocean with no alternates available. Even with radio-aids to navigation, weather plays an important role because of the special problems offered by atmospheric and precipitation static, which at times blocks the radio reception facilities. Because of its size and speed the B-29 is an airplane critically affected by these static electric conditions. Whenever the radio-aids fail, good wind forecasts are the mainstay of the navigator under instrument flying conditions. The navigation problem in poor weather conditions will influence long-range fighter airplanes even more than the bombers, which, afterall, have navigators and all kinds of radio-navigation equipment. It can be foreseen that for long range fighters weather will be absolutely a matter of life and death. Small islands are the bases to which they will have to return and marginal gas reserves will make good forecasting imperative. Base weather conditions at the present B-29 Bases in POA are only rarely below the necessary minima for take-offs or landings and then only for brief periods of time in intense shower. For the fighters, which will be based much closer to the bad weather belt, great difficulties can be foreseen regarding take-off and landing conditions.

Other special weather problems connected with VLR operations are icing and turbulence. How important an element icing will be during operations in the dense, high reaching cloud masses of the summer monsoon remains to be seen. In operations of VLR a/c in CBI last year, occasional trouble was encountered. Turbulence, while perhaps not as important as the previously mentioned weather factors also plays a role. In one case on record, turbulence has caused the bombs of a B-29 to break lose from their shackles and fall through the closed bomb-bay door and of course, not on the target. That may be a singular instance, but the more subtle effects of turbulence cannot be neglected. One is gasoline consumption. Present records indicate that high turbulence will lead to greater gas consumption. Another factor is crew fatigue. Long range missions of perhaps 15 hours of flight are fatiguing in themselves. Add to this the nervous strain of combat, then severe turbulence is an unwelcome additional factor of fatigue.

A final point is that base weather conditions on days when no combat missions are flown, have an influence on VLR operations. Hurricanes or tornadoes that strike the bases can create more havoc than enemy action. Such special events have to be foreseen. Evacuation schemes based on good forecasting have to be planned for. Base weather conditions also have an important bearing on maintenance work. Present facilities require repair and maintenance work in the open. Excessive heat, as has been encountered in the pre-summer monsoon season in India, will permit no day-time maintenance work. Hence aircraft that are non-operational will remain longer in that condition when such weather prevails. Frequent,



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excessive rainfall as in normal during certain parts of the year on the bases in the Marianas also has an adverse influence on maintenance work. Even here good forecasting, although it can not change conditions, can contribute to mitigate the effects by permitting certain adjustments in work planning.

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1 June 1945

NOTE FOR DR. ROBERT L. STEARNS

Subject: Weather Studies.

The Following problems involving weather still require study and analysis for the Twentieth Air Force. On some of them data have become available only recently to allow satisfactory study. These are:

1. Influence of weather on ground-air communications. This involves one part of the precipitation static problems.

2. Influence of cloudiness on effectiveness of operations. It is contemplated to use:

a. Latest bombing accuracy results from Eighth Air Force

b. Accumulated data from XX and XXI Bomber Command

3. Study of influence of weather on Photo Reconnaissance missions.

4. A more detailed study on "incendiary weather". This should include:

a. Fire wind measurements

b. Problem of smoke accumulation and dissipation.

5. Study of relation of weather to abortive sorties.

6. Study of accidents of B-29 caused or influenced by weather. This should include furthur investigation of the lighting and turbulence accidents.

7. Test of the reliability of weather forecast for past operations; this is to include a test of whether improvement is shown in the forecasts.

8. Miscellaneous minor project, mostly of monitoring or exploratory character, including:

a. Use of radio-facsimile for transmission of weather information.

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b. Development of instruments for weather reconnaissance and bad weather flying.

c. Training of staff weather personnel for B-29 units.

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HEL/rab Ext. 4719

16 March 1945

NOTE FOR COLO EL COMBS, DEPUTY CHIEF OF STAFF, COMBAT OPERATIONS

Subject: Report by Dr. Williams and collaborators on, "An A Priori Appraisal of Weather Squadrons"

1. The gist of the results of this report is that with normal probabilities and with reasonable assumptions on forecast accuracies, weather reconnaissance can be expected to add one clear day per summer month, that could be exploited for bombing but would under current conditions not be forecast as such.

2. Actually, the paper formalizes in the language of the statistician estimates made by the undersigned on the confidence level of weather forecasts as they are made at present and the increase in confidence for cloudiness forecasts over targets during the summer months, provided sufficient weather reconnaissance is available.

3. In the ideal case the meteorological forecast would be 100 percent correct and then all clear days could be exploited for missions. Even under the best circumstances such accuracy is not achieved in practice. Moreover, all estimates of possible missions are based on "normal" weather conditions. In any given year wide variations from normal have to be expected. This has to be kept in mind when interpreting Table II on Page 7 of the report. Emphasis has to be placed also on the fact that "1 1/2 targets" were used for the report. This means part of the time all targets in the same general area have the same weather, but at times some of them are open, others closed. On days with clear weather over the total target area, theoretically, two targets could be hit on the same day.

4. On Page 8 of the report it is rightly pointed out that a price has to be paid for weather reconnaissance, because it may require diverting a certain part of the striking force for that purpose. It should, however, be noted that the example used is very unrealistic because it foresees diversion of about 8% of the striking force for weather reconnaissance. The actual force needed is much smaller and hence the price to be paid for gaining one additional visual bombing day per summer month, is probably negligible.

5. As a minor point it should be remarked that where the report mentions "weather squadrons", actually "weather reconnaissance squadrons" are meant.

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24 March 1945.

MEMORANDUM FOR DR. ROBERT I. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION.

Subject: A Tactical Success of Spot Weather Information In Flight.

1. Combat Mission Report Number 37 of the XX Bomber Command clearly indicates that the success of this mission directed against the Railway Workshops at Kuala Lumpur on 19 February 1945 was mainly due to spot weather reconnaissance.

2. From the report the following details can be gathered:

a. The weather forecast for the target called for 5/10 stratocumulus and cumulus clouds at 2000 to 5000 feet and another layer of 5/10 altostratus at 12000 to 13000 feet. Under such conditions visual bombing from altitudes above the upper cloud layer would have been very doubtful.

b. The command planning called for bombing from 18000 feet for one group and from 20000 feet for another group. However, in view of the anticipated weather conditions it was decided to send a weather reconnaissance plane, carrying a Wing Commander, over the target area prior to the arrival of the strike force at the assembly point. The Wing Commander was to designate the best altitude for visual bombing between 10000 and 20000 feet, based on cloud cover over the target. This information was to be transmitted over liaison radio 30 minutes prior to the time the first formation was to leave the assembly point and at stated intervals thereafter to insure maximum recertion.

c. Weather at the target verified the forecast quite well. Observed were 1 to 5/10 stratocumulus or cumulus at 3000 to 5000 feet, and 5 to 7/10 altostratus at 13000 to 14000 feet. The Wing Commander in the weather reconnaissance airplane therefore designated 11000 feet for one group and 13000 feet for the other group as bombing altitudes.

d. All bombing was accomplished visually and 67.8% of the bombs fell within 1000 feet of the aiming point. The target was considered to have been damaged to the extent of 67% of the existing facilities.

e. It is stated in the mission report that "the use of an advance weather ship met with favor by the groups since it relieved the element of doubt as to target weather conditions".

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3. This constitutes the first case of spot weather reconnaissance on a strike mission fo the XX Bomber Command. The result of the mission fully warranted the use of an aircraft for the purpose. Had the mission been flown at 17000 to 20000 feet, as originally planned, the probability for visual runs would have been only about 20%, i. e., only about one fifth of the force could have been expected to drop its bombs visually. The reduction in accuracy would probably have lead to a reduction of not more than 15% of the target. The spot weather reconnaissance probably made the strike 4 1/2 times as effective as would have been without.

4. The implications of this case of tactical use of spot weather reconnaissance are obvious and it can only be strongly recommended that such a procedure be adopted wherever feasible. It seems especially useful, when the forecast calls for several cloud layers, or layers at heights below which bombing would still be tactically possible. It is urged that the Commands of this Air Force adopt this procedure in their tactical doctrines.

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HELMUT E. LANDSBERG,
Operations Analyst,
Twentieth Air Force.

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23 March 1945

MEMORANDUM FOR Colonel C. F. TIEMAN, WEATHER DIVISION.

Subject: Reports on Weather From Field Air Forces For Operations Analysis.

Pursuant to our recent conversation I am inclosing a form which contains the type of information that may be desirable for operations analysis. It was held to the mimimum to avoid unnecessary burden on communications. Detailed analysis would have to await the formal mission reports, weathermaps, etc., anyway. Three (3) samples of possible messages are also attached.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force



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Suggested Forms:

1. Date

2. Forecast Cover Period from_____to_____

   a. Weather Operational, target condition_____

   b. Weather Non-Operational cause_____

      (1) Base conditions

      (2) Route conditions

      (3) Target conditions_____

3. Influence of forecast on Command decision

4. Mission not flown due to circumstances other than weather

5. Amendments to previous day's forecast and Command decisions.

6. Observed (or/estimated) weather conditions verifying previous days forecast. (Only to be stated if different from forecast)



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Example 1.

Staff Wx Officer Nth Comber Command

1. 23 March 1945

2. 0200Z - 2000Z

Operational, target 3/10 cu

3. Maximum effort set-up

5. 22 March 1945

Front moving over tgt., fcst. changed to 10/10 multilayer, mission

6. 8/10 over tgt.



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Example 2

Staff Wx Officer Nth Bomber Command

1. 24 March 1945
2. 0200Z - 2000Z
3. Non-operational

   Target conditions 8/10 multilayer cld.

   No mission
5. None
6. Tgt. 4/10 clds.
7. 30 o/o bombs dropped by radar.

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Example 3

Staff Wx Officer Nth Bomber Command

1. 25 March 1945
2. 0200Z - 2000Z

   Operational, tgts. cavu
4. No aircraft available
5. None
6. 10/10 multilayer cld.



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5 April 1945

MEMORANDUM FOR COLONEL DON R. YATES, CHIEF, WEATHER DIVISION, CC&R

Subject: Suggestions for Improving Forecasting in the Far Eastern Area.

1. a. From the point of view of the Twentieth Air Force Operations, one of the most important forecasts is the cloudiness forecast for the targets. This will be a very critical problem in the next few months and particularly during the period of the Summer Monsoon Regime. Very few visual bombing days can be expected during that period and maximum number will have to be exploited.

b. From inspection of numerous Weather Maps of the past, it appears that clear days are most likely to occur when there is a weakening of the monsoon current in the lower layers of the atmosphere. It also appears that this weakening is related to pressure changes in the permanent centers of action, both on the Northern as well as the Southern hemisphere in the Pacific Ocean Area.

c. It is, therefore, suggested that a high priority research project be set up that would investigate the features of the monsoon current and its influence on target cloudiness in Japan by means of isallobaric maps using intervals of 24, 48, 72 and perhaps even 96 hours.

2. a. Next to the cloudiness, the most important weather item that might influence operations in that area about which insufficient meteorological knowledge exists is the formation and tracks of typhoons. It is realized that this problem may not be amenable to solution in a brief period of time.

b. However, it seems that Rev. C. E. Depperman has made pertinent investigations which were destroyed during the Japanese occupation of the Philippines. It is suggested that an attempt be made to have Fr. Depperman reconstruct his studies on the subject by means of the available surface and upper air material, and if such material is not available in the far Eastern area, that he direct a research project along the lines pursued by him before in another area where sufficient basic information is on hand here in Washington. It is further suggested that he be given sufficient assistance to carry on this project to an early conclusion.

3. a. There is at the present time sufficient doubt whether or not the inadequacies shown in day by day forecasting in the field are due to insufficient meteorological knowledge. It has been stated frequently that a considerable part of the difficulties encountered is due to the inexperience of the forecasters, the tremendous pressure under which they work and to the inability of applying all known techniques.

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b. It would, therefore, seem desirable to explore the possibility of sending a team of experienced Civilian forecasters into a forward area and have them forecast side by side with the Army forecasters, basing their forecasts on the same basic information. In the past, Civilian consultants have worked as individuals in forecast centers, essentially as advisors and teachers. There has never been an attempt to pool all the talent and see if maturity of experience, knowledge and training could improve the forecast. Only if such a trial were made could it be conclusively shown that current techniques are either incapable of handling the forecasting job or that existing knowledge is inadequate.

c. Such a forecast team, not burdened by direct responsibility for operatinal forecasts, should perhaps try to do the short range forecasting for 24 and 48 hours, and these could be checked against the forecast made by the corresponding Army Weather Officers. Due to the fact that it is generally agreed that current techniques are inadequate for accurate longerq range forecasting, no attempt should be made for such extended forecasting by this team. For the Pacific Ocean Area such a team might advantageously comprise the following meteorologists:

Dr. Bjerknes (moderate latitude analysis)
Mr. Dunn (low latitude analysis)
Mr Bellamy (upper air analysis)
Dr. Willett (hemisphere analysis)

To this group of men perhaps a Climatologist might be added. This team ought to have, of course, the support of the necessary plotters and technical aides. It would seem that after an initial period of perhaps 30 days in which the groups might get organized and develop its procedures and actual trial period of 30 days of day by day 24 and 48 hours forecasting will furnish sufficient test material to see if the techniques of forecasting known at present and used by some of the most experienced men in the field can yield better results than those of regular Army forecasters.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division

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31 March 1945.

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION.

Subject: Normal Cloud Heights Over SE Honshu.

1. With reference to your recent inquiry on probabilities of cloud layers at various levels of Japan I have tried to obtain some information of this subject. The data given below are based on a very scanty observational material and can serve only as a first orientation on the subject.

2. The Japanese have never published any ceiling observations and the only material that I knew of was a set of pilot balloon observations at the observatory at Tateno, about 20 miles from Tokyo, 1926-31. The disappearance of the balloons at low levels could be taken as normally indicating a ceiling. Another set of cloud height observations was made from 1927 to 1929 at Nera also in the vicinity of Tokyo. The total material comprises only about 3000 observations and did not lend itself to a breakdown by months. The best that could be attempted was a division of the data into cold season and warm season.

3. The percentage frequency of clouds at various levels is given in the following table, disregarding all observations of clouds above 30000 feet. It should be noted that the steps of height are not equal increments.

| Height above ground (ft) | Cold Season (Oct. - Mar.) | Warm Season (Apr. & Sept) |
|---|---|---|
| 0-1300 | 8 | 9 |
| 1300-2000 | 4 | 8 |
| 2000-3400 | 10 | 12 |
| 3500-4900 | 22 | 19 |
| 4900-6600 | 15 | 12 |
| 6600-10000 | 11 | 5 |
| 10000-16000 | 7 | 10 |
| 16000-23000 | 13 | 12 |
| 23000-30000 | 10 | 13 |

4. Again emphasizing the limitations of the raw material, this shows that during both seasons about 60% of the cloud covers are below 6600 feet elevation, if clouds above 30000 feet are neglected.

HEL:evd

H. E. LANDSBERG,
Operations Analyst
OAD, Twentieth Air Force

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26 May 1945

MEMORANDUM FOR: DR. ROBERT L. STEARNS, Chief
Operations Analysis Division, Twentieth Air Force

Subject: High Winds at Tokyo on 25/26 May 1945.

1. Reports from Radio Tokyo to the effect that winds of 70 miles per hour were observed during the incendiary attack of 25/26 May 1945 by the XXI Bomber Command have been subject to a preliminary inspection from the meteorological point of view.

2. The matter was discussed with Major Corwin and his associates of the Forecast Branch of the Weather Division. All available material on the general weather situation just prior to the raid was received.

3. There is no indication in the now available weather data that the surface wind at Tokyo just prior to the raid could have exceeded 25 miles per hour. Even that is a maximum estimate on the basis of the available information.

4. If actually winds of 70 miles per hour were observed, they could only be interpreted as fire winds, created by the up-drafts in the conflagration itself. Such winds, on the basis of experience gathered from incendiary raids on German Cities, might be possible. The fire wind as a factor in incendiary attacks, has been discussed in previous memoranda written in the middle of October 1944 and on 20 December 1944.

5. In the period from 1886 to 1929, a period of 44 years, the maximum wind speed at the surface ever observed during the month of May at Tokyo has been about 59 miles per hour. Not only is it rather unlikely that this should be exceeded by as much as 11 miles per hour on a sustained basis, but it is even more unlikely that this should have happened at the time of the attack on 25/26 May 1945 under these apparently prevailing weather conditions.

6. It is suggested that the announcement of Radio Tokyo may have been made in order to give a false impression on the results achieved with the purpose in mind to make us write off the target as "wiped out" and not worth any further effort.

H. E. LAMDSBERG
Operations Analyst

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CST/H.E. LANDSBERG/rab/4819

9 June 1945

NOTE FOR LT. COLONEL W. R. SWAIN, FLYING SAFETY, ROOM 4D-157

Subject: Weather Conditions on Okinawa

1. In the New York Times of 9 June 1945 appeared a dispatch from W. H. Lawrence, War Correspondent, that throws some additional light on weather conditions on the island of Okinawa.

2. The following extract is quoted from this report:

"They call it Onna Talse. (Talse in Japanese means "hill"). It is a small isolated knob jutting 1100 feet above the East China Sea on the northern coast of Okinawa..."

"

" On Onna Hill of Okinawa the Japanese had nearly the cover of night by day to carry on their plotting because when the sun should have been shining the prevailing low ceilings of clouds over this area covered the crest almost constantly with mist and fog...."

"For nine days...Japanese controlled height against increasing assault of doughboys... They had to be rented out and there followed what the doughboys who fought there call "The Battle in the Clouds....."

3. While low ceilings at frequent intervals could be inferred for this season of the year from the general weather conditions in the area, this is the first quantitative reference to such occurrences. The height of the hill clearly indicates that ceilings below 1000 feet are prevalent. This again emphasizes the need for early plans for instrument approach traffics control if and when bombardment aircraft are based on this island.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

4 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Weather Reconnaissance Equipment for B-29s.

1. There exists an urgent requirement to equip B-29s used for weather reconnaissance with radiosondes that can be dropped from the airplane and for an adequate receiver for recording the data furnished by the radiosonde. All of the Equipment desired is airborne.

2. a. The radiosonde desired should be capable of transmitting atmospheric pressure, temperature and relative humidity with the same accuracy as the now existing radiosondes used for aerological soundings from surface stations.

b. (1) The transmitter of the radiosonde should be a frequency modulated type in order to overcome the natural radio-noise level prevailing in the B-29.

(2) The signal of the transmitter should be strong enough to permit reception at a distance of about 100 miles from the point where the radiosonde is dropped. This is necessary in order to enable the aircraft to proceed on its course without necessitating circling over the spot where the radiosonde is dropped.

c. Parachute equipment is required for dropping the radiosonde at a rate of about 1000 feet per minute.

d. Weight considerations for the radiosonde are of secondary importance since the equipment is to be dropped, rather than ascending, as is the case with the ordinary radiosonde.

3. A light-weight recorder for the reception of the radiosonde data in the airplane is required. The reliability and accuracy of this equipment should be of the same order as that of the corresponding ground equipment. Since this piece of equipment constitutes an integral part of the fixed installations on the aircraft the weight should be held to a minimum.

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4. It is understood that the Signal Corps has for a considerable period of time experimented with the regular type radiosonde but has found that this equipment is unsuitable for use from aircraft.

5. Major Yate's office (M&S) informed me that designs of a type of radiosonde more suitable for the purpose are being developed under a high priority by the Signal Corps Laboratories. This work is being coordinated by Colonel Duffy, Air Corps Liaison Officer at Fort Monmouth.

6. a. A suitable design seems to be available now at the Meteorological Research Laboratory at the University of Chicago. Dr. Michael Ference, who is in charge of this work, told me yesterday that they will have available within two weeks for flight test three (3) models of a new radiosonde, that will meet the requirements outlined in paragraph 2. The Second Air Force is prepared to drop these radiosondes from B-29s and take records in one of their airplanes.

b. A light-weight recorder, suitable for installation in aircraft has been developed some time ago by Mr. Suomi at the University of Chicago. This design was turned over to the Signal Corps. A duplicate will be constructed for the tests at the Second Air Force.

7. It is recommended that:

a. OC&R be informed of the urgent need for the radiosonde equipment for use by this Air Force. Paragraphs 1 to 3 incl. of this memorandum can be used as basis for setting up the requirement.

b. The status of the Signal Corps developments along this line be ascertained and if necessary the work speeded up.

c. The University of Chicago equipment be flight tested and, if suitable, arrangements be made to acquire the designs and manufacture be initiated through the proper channels.

H. E. LANDSBERG,
Operations Analyst,
OAD, Twentieth Air Force

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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11 May 1945

The Use of Radar for Circumnavigating Towering Clouds

1. Even the largest airplanes, including the B-29, are endangered when entering areas of severe turbulence. These areas are generally characterized by towering cumulus clouds or cumulonimbus clouds.

2. It is a matter of record that under such conditions B-29 airplanes have suffered severe damage or have been completely destroyed. Several examples should suffice to illustrate this point. These have been collected from foreign as well as domestic areas.

a. On 11 January 1945 on a combat mission against Singapore a B-29 of the XX Bomber Command ran into severe turbulence near the target. The crew was fortunate enough to survive the experience and give a graphic account of the flight. The following extract is presented from their story: "At 0152 we hit a storm and were caught in a down draft which sent us from 24,000 feet to 12,000 feet at the rate of 6,000 feet per minute or better. An up-draft hit us and we climbed (under some control) to 25,000 feet. Both the pilot and co-pilot fought the controls to keep the plane out of a spin. Depressurization was effected by the engineer, but by this time the storm affected the airplane in such a manner as to make it nearly impossible for all crew members to put on oxygen masks. The radar operator's seat was torn from floor before the operator had a chance to put on his mask. He held on to the table, but the table also jarred loose. The top-gunner suffered shock from severe jolting and crawled down later with an upset stomach. Bombs were sheared from their shackles and driven through the bomb bay doors at approximately 0200A. The pilot and co-pilot finally effected a recovery at approximately 0210 A."

b. On 8 February 1945 at 1900 A a B-29 flying SE of Sylhet, India, tried to top a thunderhead. Failing to succeed, the airplane, while in a bank, entered the cloud. The airplane turned over on its back and dove down and completed two inside loops. After the aircraft came out of the second loop it went into another dive and disintegrated completely. There were four known fatalities and eight crew members are still listed as missing.

c. On 2 July 1944 a B-29 on a training mission ran in the vicinity of Harmon, Oklahoma into a thunderstorm. Weather conditions indicated 10/10 overcast at 2,500 feet. Flight was planned at 20,000 feet. The pilot lost control of the airplane. It was completely wrecked, with eleven fatalities resulting. In the opinion of the accident investigating committee the air plane failed structurally due to high stress from turbulence within the thunderstorm.

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c. On 4 July 1944 a B-29 on a training mission skirted the back edge of a thunderstorm. Weather was overcast at the time with light rain. Airplane crashed after entering cloud. According to survivors "it was awfully rough". Turbulence was, undoubtedly, a contributing if not the major factor in this accident which resulted in a complete wreck, six fatalities, one minor and four major injuries.

3. From the view point of flying safety it is most advisable to avoid flight through thunderstorms and towering cumulus clouds if at all possible. In addition to the safety factor, gasoline consumption is materially increased by flight through areas of severe turbulence. This latter consideration alone would warrant the avoiding of storm areas in combat flying where gasoline reserves are often critically short.

4. Experience has shown that airborne radar sets can be used to the greatest advantage to circumnavigate areas of clouds with considerable vertical development. Special reference is made to a report by the Staff Weather Officer of the 40th (VH) Bombardment Group, dated 10 March 1945 with pertinent radar scope photographs.

5. Recent combat mission reports, invariably refer to the use of radar equipment to steer aircraft around the areas of most intense cumulus cloud developments. A list of pertinent quotations from mission reports of both the XX and XXI Bomber Commands are given in paragraph 6.

6. a. Mission 11 (XXBC), 16 October 1944, aid in penetration of fronts was also provided by both the AN/APS-15 and the SCR-729 radar sets.

b. Mission 24 (XXBC), 2 January 1945; Navigation by radar through storm clouds was reported.

c. Mission 27 (XXBC), 11 January 1945: Range of radar was somewhat reduced at the target by strong return from thunderheads.

d. Mission 33 (XXBC), 1 February 1945; Radar was of importance in navigating through a tropical front. It was also used to detect severe weather disturbances along the course.

e. Mission 35 (XXBC), 7 February 1945; Radar was a great aid in avoiding many storm areas.

f. Mission 37 (XXBC), 24 February 1945; Radar was particularly valuable in directing aircraft around storm areas.

g. Mission 38 (XXBC), 24 February 1945; Many storm areas and severe weather was encountered on the mission and radar was reported a great aid in directing aircraft around these areas.



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h. Mission A1 (XXIBC), 2 March 1945: A number of severe storms were encountered again over the route and frequently identified by radar, thus aiding navigation through the less turbulent areas.

i. Mission A2 (XXIBC), 12 March 1945: Storm conditions were again noted on the route. Radar equipment was used during these periods extensively for navigation.

j. Mission 10 (XXIBC), 3 December 1944: Cumulus clouds were detected by radar in numerous instances.

k. Mission 34 (XXIBC), 15 February 1945: Successful use of radar equipment was made during penetration of a broad weather front.

7. From the foregoing the following conclusions can be drawn:

a. Severe turbulence as encountered in towering cumulus and cumulonimbus clouds is a potential hazard to B-29s.

b. Airborne radar equipment is very useful in discovering these types of clouds and is used to circumnavigate them. By inference, this makes airborne radar equipment a useful adjunct to other weather reconnaissance equipment.

8. Recommendations based on these conclusions are:

a. Train all radar operators in distinguishing cloud responses.

b. Make appropriate literature, such as the Army Air Forces Manual No. 80 available to all operating squadrons.

c. Have, as far as it is not yet done or planned, airborne radar sets in all weather reconnaissance aircraft.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

5 Jan 45 RLS
Date Initials

5 January 1945

A NOTE FOR THE INFORMATION OF:
COLONEL J. K. BROWN, JR., TWENTIETH AIR FORCE

Subject: Radio Facsimile Transmission of Weather Maps.

1. Pursuant to our recent conversation the subject of radio facsimile transmission of weather maps was taken up with the Air Communications Officer.

2. General Mc Clelland thinks that facsimile transmission of weather maps is technically feasible. He seemed to be very favorably inclined toward a project of radio facsimile transmission of weather information in the Far East.

3. The communications problem for transmission of weather information is admittedly a knotty one. By ordinary radio or radio teletype transmission a good deal of time is lost and the circuits usually stay busy .24 hours a day. If data from one region to the other are exchanged by facsimile transmission a great deal of time and effort is undoubtedly saved. On completely plotted maps all necessary information is entered, and if the information comes through the facsimile transmission, this is far more desirable than the transmission of "canned analyses".

4. General Mc Clelland considered it technically possible to transmit the information even over such long range circuits as Guam to Kharagpur or Guam to Chengtu. In that case long wave transmission will have to be used. Problems that arise are:

a. The security question since it is possible that the enemy may intercept the transmission. The joint Meteorological Committee which regulates security of weather information has in the past taken a very dim view of any kind of weather transmission in the clear. It may be needed to convince them that the advantage accruing to the enemy from the interception is not nearly as great as that accruing to our side. General Mc Clelland takes that attitude and thinks that the matter should be presented again to the JMC.

b. The allocation of a radio channel for facsimile transmission. This would have to be cleared with the appropriate theater commander.

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5. Radio facsimile transmission of weather briefing charts between units of the Twentieth Air Force based on neighboring Pacific Islands will eventually be a great help in the coordination of missions. Use of such charts transmitted between various headquarters in U. K. was a distinct help. General Mc Clelland expressed the opinion that "line-of-sight" directed short wave transmission may be feasible. In his opinion that would practically eliminate the security problem for these inter-island transmissions. He indicated that he would follow up the whole matter.

6. It would seem to be desirable to ascertain from the weather officers involved, Colonel's Stone and Ellsworth, what they think about the use of radio facsimile and if their reaction is favorable, set up the requirements and tackle the security problem in cooperation with the Air Communications Officer.

H. E. LANDSBERG,
Operations Analyst,
OAD, Twentieth Air Force.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By Authority of the Chief of Staff
Army Air Forces
8 Jan 45 RLS
Date

FOR VICTORY
BUY UNITED STATES WAR BONDS AND STAMPS

8 January 1945

A NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Radio - facsimile Transmission of Weather Maps.

1. Colonel Floyd Wood, Acting Chief of the Weather Division, called me up this morning with regard to the memorandum I recently prepared for Colonel Brown on the above subject matter. Colonel Brown had sent this for recommendation to the Weather Division after I had discussed the matter with him.

2. Colonel Wood said that he was completely in favor of our recommendations but that he thinks we would not have "a ghost of a chance" to get the security regulations removed. The weather security goes even beyond the Joint Meteorological Committee (which is on the level of the Joint Chiefs of Staff) and is handled by the combined Meteorological Committee (on the level of the combined Chiefs of Staff). Our allies and the Navy have consistently refused to lower security on weather and since both are involved in the Pacific War the matter will have to come before the CMC. The Army has waged a lone fight to get weather out of the "Secret" classification.

3. Colonel Wood will have to inform Colonel Brown accordingly. He will check into the security of the VHF facsimile transmission for inter-island communications and give the matter favorable consideration if that is found to be secure enough.

4. I refuse to give the whole matter up as yet, and if we can't get around the CMC, as I believe we should, there are technical possibilities to get the problem licked. Mr. Bennett informed me that he thinks there exists ATT single side band equipment on which radio facsimile can be scrambled. We will see Colonel French of the Signal Corps on that. If that equipment exists I will get all the information and get it to Colonel's Wood and Brown.

H. E. LANDSBERG,
Operations Analyst,
CAD, Twentieth Air Force

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8 June 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Radio Facsimile Transmission of Weather Maps.

1. This is a follow up on two memoranda which I wrote to Colonel Brown and you in January. As you will recall we discussed this subject at the time with General McClellan and Colonel Wood, who was then Acting Chief of the Weather Division. All concerned at that time were in agreement that this method would help greatly in passing weather information from forecast centers to isolated operating commands. The main drawback was at the time that existing systems could not meet military security requirements.

2. During the intervening period I took occasion to talk this matter over with Mr. Jones, who was communications expert in Dr. Bowles office, and with Mr. Alexander of the Electronics Department of the General Electric Company. Last week Mr. Alexander sent me a memorandum on the Bartelink System of secret radio transmission which can be used for facsimile sending. I have given this memorandum to Colonel Lamb in the Air Communications Officer's office and he will have it reviewed by some of the experts in that office. He promised me to return it with their comments. Colonel Lamb was very much in favor of using this system, if considered feasible and secure, for the transmission of weather information. I also briefed Colonel Twadell, Acting Chief of the Weather Division, on this development and he agreed that facsimile transmission would be a great help in communications for the weather services.

3. I would like to point out again that, in my opinion, a requirement exists for radio facsimile installations in order to coordinate weather briefing between Central Headquarters and Forward Bases in the Pacific War Zone. This particular need already exists for the coordination of bombers operating out of the Marianas and fighters operating out of Iwo Jima. The need will be intensified if eventually triangular coordination will be needed between the Marianas, Iwo Jima and units to be based on Okinawa. If past experience teaches us anything, it is that the commanding officers or generals of various air force units employed in coordinated strikes have to be briefed on the same prognostic weather map. Such a map

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should emanate from the Weather Central best prepared to issue forecasts. The translation of a weather map into a code such as is used at present for the so called "canned" analysis is only a second choice substitute for the complete map.

4. As long as weather remains one of the chief obstacles to Very Long Range air operations, it is necessary to effect the maximum coordination between weather forecasting and weather briefing officers. A secure system of radio facsimile would tremendously strengthen the effectiveness of weather services in widely separated localities, and the Twentieth Air Force as a major consumer of weather information should be vitally interested in this development.

HELMUT E. LANDSBERG
Operations Analyst

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24 October 1944

MEMORANDUM TO: Commanding General, HEADQUARTERS SECOND AIR FORCE, Colorado Springs, Colorado.

SUBJECT: Testing of Turbulence Indicators.

1. At the request of Dr. Helmut Landsberg, the AAF Weather Wing placed me on temporary duty with Headquarters Second Air Force, Colorado Springs, Colorado for the purpose of testing a turbulence indicator which had been developed at the Department of Meteorology, University of Chicago, Chicago, Illinois. This instrument was developed on a cooperative project of the Department of Meteorology and the AAF Weather Wing.

2. I first reported to Headquarters Second Air Force on 12 October 1944 and after conferences with members of Operations and Analysis Section and the Special Projects Section, M and S, proceeded to Alamogordo AAB on 17 October 1944. After testing the turbulence indicator in four flights of B-29, returned to Headquarters Second Air Force for this report.

3. This turbulence indicator is an accelerometer, except that instead of reading in terms of the number times acceleration of gravity, an electronic circuit adds a time interval into reading. Therefore if a jolt is repeated within a given time interval the instrument maintains its reading. The instrument in its present form is 8 inches wide, 5 inches high, and 5 inches deep. The primary source of energy is 24 volts D.C. The weight is about 5 pounds. It is completely portable as the indicating meter has its own shock proof mount, and can be plunged into standard 24 volt suit heater circuit.

4. The present instrument was flown a total of 15 hours in B-29 at Alamogordo AAB. There are 100 divisions on the indicating meter. The calibration is as follows: 0 to 10 - no turbulence, 10 to 30 - light turbulence, 30 to 60 - moderate turbulence, and over 60 heavy turbulence.

5. The purposes for which this instrument could be used are:

a. Effect of turbulence on fuel consumption.

b. Effect of turbulence on pilot and crew fatigue.

c. Effect of turbulence on bombardment and gunnery accuracy.

d. Measurement of turbulence in Weather Reconnaissance.

6. The instrument is in such a form that it could be produced commercially, however, our laboratory wants to investigate one or two ideas which appear to make it much simpler. In view of the great need for such an instrument, further investigations should not hinder the use of the instrument as is.

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7. Recommendations for further action:

a. That one or two addition instruments be built in our laboratories.

b. Determination of the actual values of turbulence in terms of number times acceleration of gravity and frequency of these accelerations that this calibrated instrument indicates.

c. Flight test calibrated instruments at the same time in two or more different types of army aircraft to determine the constancy that this instrument will show when operated in different types of aircraft.

d. Make some flight tests with Brown Recorders at Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota to determine whether the use of the turbulence indicator and Brown Recorder would prove of value to training personnel in training B-29 crew.

8. I want to take this opportunity to thank Dr. Joseph Kaplan, Chief, Operations Analysis Section, and his staff Lt. Col. Van Ornum of M and S, Headquarters Second Air Force; Lt. Col. Reidings, Director of M and S; Major Baker, Director of Flying; and Capt. Anderson, Deputy Director of West Area at Alamogordo for their excellent cooperation in carrying out this flight testing.

WILLIAM D. SCOATES
2nd Lt. A.C.

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HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D. C.

15 March 1945

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MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Airborne Turbulence Recorder

1. Attached hereto is a formal report on the tests conducted with the turbulence recorder by Lt. William D. Scoates. The equipment was tested on 10 B-29 flights in cooperation with the Second Air Force.

2. The main results of the tests are as follows:

a. The principle of the turbulence recorder developed by Lt. Scoates is operative and capable of giving objective measurements of turbulence that can either be read on a dial or be recorded continuously in flight by automatic means.

b. Turbulence indicated by the recorder correspond very well to observations by air crew members and meteorological conditions.

3. This type of turbulence recorder has the advantage of a very open scale compared to other models that have been used. It is very simple and compact. From the point of view of B-29 operations, installation of such turbulence meters in a few selected airplanes will permit to obtain correlations between turbulence and:

a. Gasoline consumption

b. Crew fatigue

c. Bombing and gunnery accuracy

d. Structural damages

In order to underline the importance of turbulence to B-29 operations an excerpt from a mission report of the XX Bomber Command is inclosed.

4. As experience with turbulence records is gained, the meteorologist will be able to make more accurate forecasts of this element. At present most turbulence forecasts are rather vague estimates. Weather reconnaissance aircraft should therefore too be equipped with turbulence recorders.

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5. It is suggested that the inclosed report be forwarded to Colonel Aldrin's Section at Wright Field. This is particularly appropriate because one phase of "All Weather Flying" is undoubtedly turbulence. I have briefed Mr. Harrison, who is to be Operations Analyst with Colonel Aldrin, on the existence of this equipment. It might be a propos to suggest to Colonel Aldrin to procure one or more of these turbulence recorders and subject them to routine service tests in the program of his section. If he finds them suitable a requirement for a limited number for B-29s might be set up to obtain analytically valuable data on the subjects indicated in Paragraph 3.

1 Incl.
XX B.C. Report

HELMUT E. LANDSBERG
Operations Analyst

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PRELIMINARY ANALYSIS OF THE INFLUENCE OF WEATHER

ON B-29 MISSIONS NO. 1 TO AND INCLUDING NO. 8, XX BOMBER COMMAND

CONTENTS

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2. Procedure

3. Effect of Weather on Missions as a Whole

4. Effect of Weather on Component Elements of B-29 Operations

5. Weather Forecasts for Missions

6. Conclusions

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Appendix. Analysis of Influence of Weather on Individual B-29 Missions 1 - 8

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By Authority of
The Commanding General
Army Air Forces
26 Nov 44 [illegible]
Date Initials

1. Prefacing Remarks:

This analysis is entirely preliminary in character, mainly because only eight (8) complete mission reports were available for inspection. This constitutes, of course, statistically speaking, a very small sample which does not allow one to draw valid overall conclusions. The main intent of this report at the present moment is to set up a scheme for the evaluation of the weather factor in B-29 operations. This example might advantageously be followed by the operations analysis sections of the Twentieth Air Force and its component commands.

2. Procedure:

All weather factors mentioned in the complete mission reports that were pertinent to the evaluation of the effect of weather on the performance of the B-29 were entered for each mission on a separate single-sheet form. The forms as filled out for the missions No. 1 through 8 of the XX Bomber Command are assembled in an Appendix to this report. Mission No. 7 is counted as three separate operations, two of which were combat missions and one of which was a photographic mission. This gives an overall number of ten missions that were analyzed. Some of the items specified in the analysis sheet were not applicable to individual missions; on others the available information was incomplete and hence blank spaces appear on the forms. As far as possible the original wording of the mission report has been retained. Condensations of this text have been made where no essential information was lost by this procedure. Forecasts of weather and verifications were quoted only when an important difference existed.

3. Effect of Weather on missions as a whole:

a. Of the ten missions inspected, three were seriously affected by adverse weather. In these operations the weather factor either constituted an acute potential danger (although no operational losses have so far been directly attributed to weather) or the mission did not, in part, fulfill its purpose. These missions were Nos. 1, 3, and 7A. The following paragraphs from the evaluations of the missions are quoted to sub-

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stantiate this statement:

Mission No. 1: "As a result of unfavorable weather conditions the Command was unable to fulfill part of the mission." On landing, "Violent thunderstorms caused wide dispersal of aircraft at airports of opportunity."

Mission No. 3: "Cloud coverage of target areas.....made night photo reconnaissance ineffective." (Mission had, in part, been set up as a photo mission).

Mission 7A: "Seven aircraft (of seventy-five) landed short of bases as a result of low fuel supply; many others had hardly enough fuel. Operational losses can be anticipated to be high when unexpected bad weather is encountered."

b. One of the missions was particularly favored by good weather, as stated in the report:

Mission No. 8: "Weather conditions were favorable for visual bombing, good for navigation, and excellent for communications."

4. Effect of weather on component elements of B-29 operations:

a. All of the nine combat missions encountered weather conditions that either helped or hampered individual operational factors of B-29 operations. These influences are summarized in the following table:

Number of Cases in Which Weather Factors Materially Affected Component Parts of B-29 Operation

| Element | Favorably Influenced by Weather | Unfavorably Influenced by Weather | Weather not mentioned or indifferent |
|---|---|---|---|
| Bombing | 4 | 5 | 0 |
| Photography | 1 | 4 | 4 |
| Communications | 1 | 4 | 4 |
| Formation Flying | 2 | 1 | 6* |

* Includes night missions on which no attempt to fly formation was made.

As can be noted, the unfavorable weather influences prevailed on many occasions.

b. In the case of bombing, the major unfavorable influences were



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cloud cover and poor visibility. The present imperfections of the radar techniques employed contributed to classify these conditions as unfavorable.

c. In the case of photography, cloud cover was the major adverse factor. In that respect, Mission No. 3 is noteworthy. This mission was, in part, set up as a photographic mission. 10/10 undercast or haze obscured the target. The weather forecast for the target called for 7-9/10 cloud, i.e., the forecast was essentially correct. Nevertheless a chance on a photographic mission was taken.

d. Navigation was hampered in some cases by inability to obtain celestial fixes on long missions due to cloud cover. Mission reports also disclose that many navigators had considerable difficulty in determining winds aloft as evidenced by the wide variation of observations made.

e. Communications were adversely influenced by static and thunderstorms.

f. Formation flying, radar, and Gas Consumption: (The material is as yet insufficient to establish weather influence).

g. Miscellaneous weather effects: Nose icing and window icing was mentioned in two cases. In the report of Mission No. 8, it is mentioned that in several cases, "Windows were frosted to such an extent that bombardiers were unable to look through them and required to spend a good deal of time scraping frost from windows." (This problem is now subject of an investigation of the Operations Analysis Section of the Twentieth Air Force, designed to eliminate this trouble).

h. It should be emphasized that the greater part of the period in which missions were flown, namely June through August (Nos. 1 - 7), in the area of bases, flight routes, and targets is seasonally influenced by bad weather conditions. The difficulties encountered with cloud covers and thunderstorms are entirely normal and had to be anticipated in view of the well-known climatic conditions of the region.

5. Weather Forecasts for Missions:

a. An attempt has also been made to evaluate the forecasts as compared to the weather encountered on the missions. In the reports, these



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forecasts were generally rated as good with only a few exceptions taken to parts of individual forecasts. The following remarks are not intended as a criticism of the forecasts. It is at present not possible to evaluate the effects that various statements in a forecast may have had on the planning and execution of a mission. Furthermore, a complete evaluation of the influence of the forecasts can only be made if all forecasts, even those for days on which no missions were flown, are available and the influence of forecasts on command decisions can be weighed. It is also tacitly assumed that the forecasts made represent the best possible with the basic weather information available. Critical verification of forecasts with the view point of improving the reliability can only be made on the spot and, undoubtedly, are receiving continuous attention on the part of the weather personnel.

b. (1) The overall statements in the forecasts issued were compared to the weather given as encountered. These statements usually cover the base area at take-off and on return, the target area, various sections of the rout on the way out and on return. Each section of the forecast was evaluated in broad categories, namely, whether conditions encountered were essentially as forecast, whether they were substantially better or worse than forecast. While it is open to argument what constitutes a substantial deviation from the forecast, such was taken to exist if the mission reports indicated an exception to the forecast or if manifest changes in flying weather occurred. These were, e. g., if instrument weather prevailed instead of contact, or if a major divergence in cloud cover over the targets was indicated. The results are shown in the following table:

Comparison of Forecast to Weather Encountered*
Number of Verifiable Cases

| SECTIONS | Better Than Forecast | Essentially as Forecast | Worse Than Forecast |
|---|---|---|---|
| Bases at take-off | 2 | 5 | 2 |
| Zones of route out | 5 | 16 | 3 |
| Targets | 6 | 5 | 3 |
| Zones of route back | 3 | 7 | 1 |
| Bases on return | 4 | 2 | 3 |





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*NOTE: On routes: Various subsections of the routes were treated independently. At targets: If forecasts for different targets were made, each was evaluated independently wherever observations from any target were given.

(2) The overall picture indicates that too pessimistic forecasts prevail slightly over too optimistic forecasts. No conclusion with respect to a "bias" should be drawn at this time because the series of observations is too short for a definite statement.

(3) If the essentially correct forecasts are compared with those either better or worse than anticipated, the following picture results:

| | No. of Cases Better or Worse | No. of Cases Correct | Per Cent Cases Correct |
|---|---|---|---|
| Bases at take-off | 4 | 5 | 56 |
| Route out | 8 | 16 | 67 |
| Targets | 8 | 5 | 39 |
| Route back | 4 | 7 | 64 |
| Bases on return | 7 | 2 | 22 |

A very interesting trend is shown by these figures. The forecasts for the routes seem substantially better than those for bases and targets. This reflects in part the greater difficulty to make a forecast for a specific point at a specific time twenty-four or thirty-six hours in advance. In part, it is due to the fact that forecast errors for bases and targets are more likely to be mentioned in the mission reports because their effect on the execution of the mission is often more evident. Another point is also obvious, namely the decrease in reliability of the forecast with time. The forecasts for the bases at take-off are better than those for the targets and those in turn are better than the forecasts for bases on return. This trend will bear watching in the future to see if future reports will substantiate this finding.

(4) A slightly different attitude may be taken toward the verification of forecasts by combining those which were essentially correct and those when the weather was better than forecast. An argument can be made for this inasmuch as better weather than anticipated will help the success of the mission. (Of course, from the point of view of command

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decision the reliability of the forecast is the most important item, and an overall picture can only be gained if the forecasts for those days on which no missions were flown are considered also). The following table shows the results if correct forecasts and too pessimistic forecasts are combined:

| | No. of Cases Worse Than Forecast | No. of Cases Correct or Better Than Forecast | % Correct or Better Than Forecast |
|---|---|---|---|
| Bases at take-off | 2 | 7 | 78 |
| Route out | 3 | 21 | 87 |
| Targets | 3 | 11 | 78 |
| Return route | 1 | 10 | 91 |
| Bases on return | 3 | 6 | 67 |

The last column of this table may reflect, on first sight, a very favorable picture. It should, however, be remembered that in order to prove forecast usefulness, this figure should exceed 67% because that is what would be expected by chance with two choices out of three (correct and better versus worse).

(5) With gasoline consumption at the limit of the operational range being critical for present B-29 operations, the accuracy of upper wind forecasts gains particular importance. Reports for seven missions include forecasts and observations of upper winds. The observations in all cases showed considerable scatter, apparently because the navigators had considerable trouble in making wind observations. Hence, the verification of the forecasts is based on material open to considerable doubt. The results are as follows:

| | Number of Cases | | |
|---|---|---|---|
| Deviation Forecast vs observed Wind direction | Within 10 deg. 10 | 11 - 30 Deg. 7 | More than 30 deg. 5 |
| Deviation Forecast vs observed Wind speed | Within 5 MPH 15 | 6 - 10 MPH 5 | 11 - 20 MPH 2 |

These data are offered without comment but future attention is invited to this point because of its importance for the gas consumption



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problem.

c. In one case (Mission No. 8) mention was made that on 1 September 1944, on the basis of a weather forecast, the decision was reached that on 5 September a visual mission could not be flown against a specified target. In absence of actual observations this longer-range forecast could not be verified. However, on the date decided upon for the mission, 8 September, target conditions were essentially good. It is not known how far in advance the forecast on which the date for the mission was based had been made. In general, verification of forecasts for pin-point targets five days in advance is low and it is not ordinarily advisable to base final command decisions on them.

d. Weather forecasts for the time of the year and the area in which the first ten missions were flown, especially with the distances involved, are very difficult and the weather service in that theater will need all possible support to help the weather personnel to fulfill its mission by providing for observations and reconnaissance as well as research to advance general knowledge of weather phenomena in that area.

6. Conclusions:

a. The weather factor in the first nine combat missions of the B-29 had considerable influence. It affected bombing adversely in five of these missions and completely vitiated one attempted larger photographic effort.

b. Forecasts indicate that difficulties were encountered in making pin-point forecasts as the time from issuance increased. This was important, especially for target forecasts and forecasts for bases on return.

7. Suggestions:

a. Variability of gasoline consumption from aircraft to aircraft is such that no analysis on the wind influence upon gas consumption can be made at this moment. Route and weight data are also insufficient in the mission reports for this purpose. Wind observations themselves are deficient. This subject should be studied directly by Operations Analysts in the field who should be able to procure all the pertinent information.

b. Training of navigators with respect to making wind observations, especially under poor weather conditions, seems to be inadequate and re-



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medial steps seem indicated. The matter should be given particular attention in current domestic training activities.

c. Window frosting was mentioned in the mission reports with an indication that remedial action was under way in XX Bomber Command. Information on this point should be secured and correlated with domestic research on this subject.

d. Complete evaluation of the weather factor on the missions should include:

(1) The verification of all forecasts made.

(2) Study of influence of forecasts on command decisions by evaluation of weather briefings of operations officers. This can only be done in the field.

e. Weather briefing and weather interrogation of returning crews might well be subject of another operations analysis study. This can only be done in the field.

f. It is finally suggested that this preliminary study be expanded and revised as soon as sufficient further mission reports become available.

H. E. LANDSBERG,
Operations Analyst.

APPROVED:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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No. of Mission: 1 XX Bomber Command

Date of Mission: 6 June 1944

Primary Target: Bangkok, Thailand

1. Weather Consideration in Planning: Anticipated high temperatures resulted in decision to fly night mission (changed later by orders of higher Hq).
2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off: Low clouds and haze made assembly into 4-ship formation difficult.
      (2) Landing: Violent thunderstorms caused wide dispersal of aircraft at airports of opportunity.
   b. Route: Increasingly heavy weather made it hazardous and impractical to fly formations, increased also time aloft and consumption of gas.
   c. Target(s): 7-10/10 undercast prevented visual bombing in most cases.
3. Weather Effects on Operation:
   a. Bombing: Conditions extremely poor for visual bombing (7-10/10 undercast).
   b. Photography: Broken to solid undercast precluded adequate photographic coverage.
   c. Navigation:
   d. Radar:
   e. Communications: Excessive static caused by atmospheric conditions caused considerable difficulty.
   f. Formation flying: All formations broke up due to adverse weather.
   g. Gas consumption:
4. Abortives Due to Weather:
5. Losses Due to Weather:
6. Other Weather Aspects: One (1) nose window iced over.
7. Remarks: a. Evaluation of results by XX Bomber Command reads in part as follows: "As a result of unfavorable weather conditions, the Command was unable to fulfill part of the mission."
   b. "Of 1267 H. E. & 205 IB dropped, photo reconnaissance revealed 16-18 in target area."
   c.1. Forecast for base on return were scattered cumulus, visibility 6 miles, scattered thunderstorms. Encountered were violent thunderstorms with fresh gusts, resulting in dust storms which greatly reduced visibility. Strong crosswind made landings in base area hazardous or precluded landing altogether.
   2. Forecast for target indicated "scattered to broken cloud layers." Encountered were broken to scattered stratiform clouds and towering nimbus.
   3. Conditions as encountered are not uncommon during the period of the SW-monsoon from June through October, and they can rarely be predicted with any degree of accuracy.

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No. of Mission: 2 XX Bomber Command

Date of Mission: 15-16 June 1944 (night)

Primary Target: Yawata

1. Weather Consideration in Planning:

2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off:

      (2) Landing: Variable conditions with ceiling 500 feet and visibility 1 1/2 miles at one field.

   b. Route: Instrument flying necessary en route out as a result of heavy cirrus overcast.
   c. Target(s): Clear to 3/10 cloud at target but ground haze and smoke contributed to difficulty in visual bombing.

3. Weather Effects on Operation:
   a. Bombing: Ground haze and smoke interfered with visual bombing. A cross wind over the target may have caused aircraft to drift off course on bombing run.
   b. Photography:

   c. Navigation: On route out as a result of heavy cirrus overcast above the flight level, celestian navigation fixes were impossible until aircraft reached the coast of China. Route back weather conditions: Improved, therefore instrument flying necessary only in base area.
   d. Radar:

   e. Communications:

   f. Formation Flying:

   g. Gas Consumption:

4. Abortives Due to Weather:

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks: a. Target forecast: 7-9/10 stratocumulus; visibility 4 miles. Observed were clear conditions to widely scattered stratocumulus clouds (maximum 3/10); visibility 4 miles in haze.
   b. Forecast for bases on return: overcast; layers between 8,000 and 15,000 feet; visibility 4 miles. Encountered at the four base fields were:
      (1) 8,000 foot ceiling; visibility 5 miles.
      (2) 500 foot ceiling; visibility 1 1/2 miles; rain.
      (3) 3,500 foot ceiling; visibility unlimited; rain.
      (4) 5,000 foot ceiling; visibility 4 miles.
   c. On D + 1, one photo reconnaissance plane was unable to take off because of "adverse runway conditions." This may have been caused by weather, although it is not specifically mentioned in report.
   d. 28% of bombs accounted for in target area.

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No. of Mission: 3 XX Bomber Command

Date of Mission: 7-8 July 1944 (night)

Primary Target: Sasebo

1. Weather Consideration in Planning:

2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off:
      (2) Landing:
   b. Route:

   Target(s): Target obscured by 10/10 coverage of stratus, stratocumulus, or by haze.

3. Weather Effects on Operation:
   a. Bombing: Conditions poor for bombing.
   b. Photography: Conditions poor for photography; 10/10 undercast or haze nullified chance of success for night photography.
   c. Navigation: Full moon and good weather simplified navigation, permitting dead reckoning and celestial fixes along the route.
   d. Radar: One operator encountered confusing cloud echoes (12 planes bombing by radar).
   e. Communications:
   f. Formation Flying:
   g. Gas Consumption:

4. Abortive Attempts Due to Weather:

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks:
   a. Evaluation of results by XX Bomber Command reads in part as follows: "Cloud coverage of target areas made night photo reconnaissance ineffective." (Mission had in part been set up as photo mission).
   b. SCR-718 altimeter was used extensively by all navigators for obtaining accurate altitudes.
   c. Target forecast: Nagasaki, Omuta, Sasebo, 7-9/10 stratocumulus at 3,000 feet; visibility 3 miles in haze. Yawata, Tobata, 5/10 stratocumulus at 3,000 feet; visibility 1 mile in smoke and haze. Encountered: Sasebo 10/10 stratocumulus, tops 4,000-5,000 feet, breaks in clouds over water. Omuta clear but visibility restricted by haze. Tobata no cloud cover, haze in lower layer restricted visibility to vertical line. Omura 10/10 stratus.
   d. Base on return forecast: Broken altostratus and altocumulus at 14,000 feet; visibility 1 1/2 miles in light fog at dawn, improving to 3 miles at 0600 GMT to 6 miles at 0900 GMT. Encountered: Overcast at 8,000 feet; visibility 3 miles in haze.

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No. of Mission: 4 XX Bomber Command

Date of Mission: 29 July 1944

Primary Target: Anshan

1. Weather Consideration In Planning:

2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off:
      (2) Landing:
   b. Route:
   c. Target(s): 2/10 cirrus at 25,000 feet; 2/10 altocumulus at 10,000 feet; unrestricted visibility offered excellent conditions.

3. Weather Effects on Operation:
   a. Bombing: Cloud cover and visibility were excellent for high-altitude visual bombing; still air with negligible drift gave relatively ideal conditions.
   b. Photography: Photo plane encountered thunderstorm activity over Taku. It dropped to 9,500 feet for photo attempts. Weather prevented photography at Chinwangtao. Clear weather prevailed at Anshan, Pensihri, and Dairen, and photos were taken from an altitude of 25,000 feet.
   c. Navigation: Specific navigators varied widely concerning wind direction and velocity.
   d. Radar:
   e. Communications: Some interference due to local storms, but not serious enough to cause breakdown of communications.
   f. Formation Flying: Possible at all times.
   g. Gas Consumption:

4. Abortives Due to Weather:

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks:
   a. Target forecast: 2-4/10 high clouds at 20,000 feet with lower cumulus 2-4/10 forming by 0930, increasing in amount to 5-7/10 after 1300; visibility over 5 miles. Encountered: over Anshan (about 1200): 2/10 cirrus at 25,000 feet, 2/10 altocumulus at 10,000; visibility unrestricted. Taku: 8/10 cirrus at 25,000 feet, 4/10 altocumulus at 17,000 feet; visibility 10 miles.

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No. of Mission: 5 XX Bomber Command

Date of Mission: 10-11 August 1944 (night)

Primary Target: Palembang

1. Weather Consideration in Planning: Night mission was decided on, partly because predicted weather conditions would probably necessitate radar bombing, even in daylight.

2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off: Take-off time was advanced one-half hour because cross-winds developed sooner than forecast.
      (2) Landing:
   b. Route: Considerable thunderstorm and shower activity was encountered en route.
   c. Target(s): Palembang: Thin altostratus, 8/10, at 8,000 feet; also layer of 2/10 patchy stratocumulus. Moasi River: Weather varied from CAVU below 1,000 feet to 5/10 coverage, bases 1,000-3,000 feet. (Mines released from 350-1,000 feet). Pangkalenbradan (Secondary) 8-10/10 undercast.

3. Weather Effects on Operation:
   a. Bombing: Undercast of 7-9/10 at 8,000 feet and 2/10 patchy stratocumulus layer at 2,000 feet contributed to difficulty of bombing (1/2 of releases by radar, half (16 a/c) visually).
   b. Photography: Although 29 exposures were made, 24 negatives were not usable because of heavy cloud cover; remainder of 5 were poor-quality strike photographs.
   c. Navigation: Navigation on this long over-water mission was hampered by the inability of the navigators to take celestial fixes along the route.
   d. Radar:
   e. Communications:
   f. Formation Flying:
   g. Gas Consumption:

4. Abortives Due to Weather: 1 Aircraft was forced to return because of a combination of weather and mechanical difficulty. (54 a/c airborne).

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks:
   a. Base forecast: Cross-winds developed sooner than had been anticipated.
   b. Target forecast: Palembang: few altostratus clouds at 15,000 feet; patches of 2-3/10 stratocumulus clouds, increasing to 6/10 stratocumulus at 0600 local time, bases 1,500 feet, tops 2,500 feet; visibility more than 6 miles. Encountered: thin altostratus 8/10 at 7,000-8,000 feet, occasionally large breaks; low clouds generally 2/10 patchy stratocumulus at 2,000 feet; visibility 6 miles with haze. Pangkalanbrandan: 5/10 altostratus clouds at 13,000 feet; 5/10 stratocumulus, bases 2,500, tops 5,000; visibility more than 6 miles. Encountered: Thin altostratus overcast at 8,000 feet.

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No. of Mission: 6 XX Bomber Command

Date of Mission: 10-11 August 1944

Primary Target: Nagasaki

1. Weather Consideration in Planning:

2. Weather Conditions Affecting Execution of Mission:
   a. Bases: (1) Take-off:

      (2) Landing: Of 23 a/c returning to Chengtu area, 3 a/c had to land at different base because of ground fog at this staging base.

   b. Route: Cloud formations provided measure of protection from interception and ground fire.

   c. Target(s): Over the target scattered to broken stratocumulus and cumulus clouds at 8,000-10,000 feet covered the target from 3/10 when first a/c arrived to 7/10 when last a/c bombed. Scattered thunderstorms from the West also started in over target area.

3. Weather Effects on Operation:
   a. Visual bombing was difficult. Cloud cover varied (from 5/10 when first a/c arrived at target to 7/10 when last passed over (8 visuals, 15 radar, 1 unknown)).

   b. Photography: Cloud conditions which varied from 3/10 to 7/10 greatly hampered any chance of successful night photography.

   c. Navigation:

   d. Radar:

   e. Communications: (Transmission between China bases and Rear Hq were interrupted for 4 hours because of atmospherics) Controller experienced considerable difficulty in receiving transmissions from aircraft due to unfavorable climatic conditions.

   f. Formation Flying:

   g. Gas Consumption:

4. Abortives Due to Weather: 1 aircraft returned because of weather and radar difficulties (29 a/c dispatched).

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks:
   a. Target forecast: Overcast with tops at 3,000 feet and frequent wide breaks in target area; visibility 4 miles in smog. Encountered broken stratocumulus and cumulus, tops 8,000-10,000 feet. (3/10-7/10). Scattered air mass thunderstorms west of target moving over targets as last planes came over.

   b. Forecast bases on return: Overcast at 10,000 feet with visibility 2 miles at dawn, improving rapidly to 4 miles after daybreak. Encountered: Hsingching, broken clouds 9,000-10,000 feet; visibility 2 miles before sun-up at 0550, dropped to 1/4 mile, improved to 1 mile by 0700 and rose rapidly thereafter to 5 miles. Kwanghan: clear; visibility 1/2 to 1 mile in thin layer of haze and ground fog; field was clearly visible from above but obscured on low approach; visibility less than 1/4 mile at NW end of field. Kunghai: scattered clouds 9,000-10,000 feet; visibility 4 miles with light ground fog, improving to 7 miles with haze. Pengshan: patches of broken altocumulus at 10,000 feet; ground fog in mountain valley and at base; visibility limited to 1 mile at time of landing.

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No. of Mission: 7A XX Bomber Command

Date of Mission: 20 August 1944 (day)

Primary Target: Yawata

1. Weather Consideration in Planning:

2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off:

      (2) Landing:
   b. Route: On return frequent violent thunderstorms building up to 17,000 feet were encountered. These storms persisted inland from China coast and were most violent over hills area. St. Elmo's fire and extreme turbulence were encountered.
   c. Target(s): Clear, except for clouds N and E of target area; visibility unlimited.
3. Weather Effects on Operation:
   a. Bombing: 97% of bombing was accomplished visually.

   b. Photography: (See 7c).

   c. Navigation: Because of adverse weather conditions encountered on the return trip, requests for navigational aids were numerous. Turbulent conditions made celestial navigation difficult in some cases, and electrical disturbances affected the performance of the homing facilities in the base area. Computed winds varied considerably partly due to unfavorable weather.
   d. Radar:

   e. Communications: Atmospheric conditions were such that radio transmission was seriously hampered.
   f. Formation Flying:

   g. Gas Consumption: 7 a/c landed short of bases as result of low fuel supply; many others had hardly enough fuel. Operational losses can be anticipated to be high when unexpected bad weather is encountered.
4. Abortives Due to Weather:

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks:
   a. Target forecast: 4/10 low cumulus, tops at 6,000, 6/10 altocumulus, bases 12,000, tops 14,000; visibility 5 miles in haze and smoke. Encountered: thin cirrus overcast at 30,000 feet. The forecast low and medium clouds were observed to the N and E of the target area; visibility unrestricted.
   b. Return route forecast: Scattered cumulus over land area will be built up to 15,000-17,000 feet with occasional thunder heads up to 22,000 feet; showers and moderate to severe turbulence in cumulus. Encountered: over land frequent thunderstorms were encountered soon after reaching the coast. Thunderstorms were extremely violent and were built up to 17,000 feet. They were most violent over the hills area. St. Elmo's fire and extreme turbulence were encountered. (Scattered thundershowers had been predicted for base area on return).

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No. of Mission: 78 XX Bomber Command

Date of Mission: 20-21 August 1944 (night) Primary Target: Yawata

1. Weather Consideration in Planning:

2. Weather Considerations Affecting Execution of Mission:
   a. Bases (1) Take-off:
      (2) Landing:
   b. Route:
   c. Target(s): Low thin broken to overcast clouds with considerable smoke reported by some; others indicate heavy layer of smoke and haze limiting visibility to 3 miles.
3. Weather Effects on Operation:
   a. Bombing: As a result of smoke and haze or layers of low clouds over the target, radar bombing was resorted to in the majority of instances. (36% bombed visually).
   b. Photography: (See Mission 7c).
   c. Navigation:
   d. Radar:
   e. Communications:
   f. Formation Flying:
   g. Gas Consumption:
4. Abortives Due to Weather:

5. Losses Due to Weather:

6. Other Weather Aspects:

7. Remarks:
   a. Route out forecast: (1) Hills: thick broken to overcast layers to 16,000 feet, with towering cumulus and cumulonimbus to 20,000 feet; moderate to severe turbulence in cumulus with rain and lightning. Encountered: Scattered medium clouds above 10,000 feet; 8-10/10 cumulus building up with few thunderheads building up to 16,000-18,000 feet. (2) Hills to coast: Broken, occasionally overcast, towering cumulus and cumulonimbus, tops generally 15,000 feet, occasionally towering to 20,000-22,000 feet. Turbulence, rain, and lightning in cumulonimbus. Broken altocumulus at 14,000 feet. Encountered: Broken medium clouds above 10,000 feet; 8-10/10 cumulus building to 8,000-10,000 feet, occasionally tops to 16,000 feet, decreasing in amount, becoming scattered cumulus or towering cumulus near I.P.; scattered altocumulus at 12,000 feet. Encountered: Scattered low clouds, tops near 3,000 feet.
   b. Target forecast: No low clouds; scattered altocumulus at 12,000 feet. Visibility 3-4 miles in smoke and haze. Encountered: Estimates varied considerably; some reports indicate low thin broken to overcast clouds with considerable smoke. Others indicate scattered low clouds with heavy layer of smoke and haze, limiting visibility to 2 miles.
   c. Return route forecast: Over sea same as route out. Encountered: Clear sky.
   d. Bases on return: Overcast 2,000 feet; intermittant drizzle; visibility 2 miles. Encountered: Overcast 8,000 feet; visibility 6-8 miles in light rain.

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No. of Mission: 7C XX Bomber Command

Date of Mission: 21 August 1944 (day)

Primary Target: Yawata (Photography)

1. Weather Consideration in Planning:

2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off:
      (2) Landing:
   b. Route:
   c. Target(s): Yawata: 3/10 fair weather cumulus with tops at 6,000 feet.
3. Weather Effects on Operation:
   a. Bombing:
   b. Photography: Pictures taken at Yawata had cloud cover to a degree that made them usable for photo interpretation. Weather at Fuson, Omura, and Nagasaki was clear with visibility unlimited.
   c. Navigation:
   d. Radar:
   e. Communications:
   f. Formation Flying:
   g. Gas Consumption:
4. Abortives Due to Weather:
5. Losses Due to Weather:
6. Other Weather Aspects:
7. Remarks:
   a. Forecast Base at take-off: Broken strato-cumulus, bases at 5,000 feet, tops at 7,000 feet; overcast at 12,000 feet; visibility 2-3 miles in haze. Encountered: Overcast at 10,000 feet; scattered stratocumulus at 6,000 feet; visibility unlimited.
   b. Route out forecast: (1) Hills to coast: Layer cloud decreasing to nil; variable cumulus 4-6/10 with broken cirrus layer occurring about 116 degrees E. Cumulus generally small. Upper stratiform layers became thin altostratus layer at 15,000-17,000 feet amounting to 7/10.
   c. Target forecast: Scattered cumulus, 8-10/10 cirrostratus at 30,000 feet; visibility more than 10 miles. Encountered: 1/10 cirrus at 30,000 feet over target. Yawata: 3/10 fair weather cumulus, tops at 6,000 feet; few widely scattered patches of altocumulus at 17,000 feet and 24,000 feet; visibility unlimited. Other targets clear with unlimited visibility.

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No. of Mission: 8

XX Bomber Command

Date of Mission: 8 September 1944

Primary Target: Anshan

1. Weather Consideration in Planning: On 17 August, D-day was set for 5 September. However, forecast indicated that visual bombing would not be possible on 4 September. It was planned to run mission as soon as weather conditions allowing visual bombing were indicated.
2. Weather Conditions Affecting Execution of Mission:
   a. Bases (1) Take-off:
      (2) Landing:
   b. Route:
   c. Target(s): 1st a/c over target reported clear; last 3-6/10 fair weather cumulus with visibility unlimited.
3. Weather Effects on Operation:
   a. Bombing: Generally favorable for visual bombing. Smoke and cloud, however, obscured the target to the extent that several formations used offset aiming points. Frosting of windows interfered. (See 6 below).
   b. Photography: Photo recon plane had CAVU weather over all targets: Laoyao, Tsengtao, Dairen, Anshan, Chengwengtao, Peking.
   c. Navigation: Because of reasonably good weather, navigators were able to make dead reckoning calculations with the aid of pilotage, and in some cases, of sun lines with reasonable success. Felt weather eliminated difficulties experienced on previous missions. Computed winds varied considerably.
   d. Radar:
   e. Communications: Weather conditions were excellent; interference by static was at a minimum.
   f. Formation Flying: Formations could be maintained at all times.
   g. Gas Consumption:
4. Abortives Due to Weather:
5. Losses Due to Weather:
6. Other Weather Aspects: Several a/c reported that windows were frosted to such an extent that bombardiers were unable to look through them and were required to spend a good deal of time scraping frost from the windows.
7. Remarks:
   a. Forecast rated as excellent; no unusual or extreme weather that affected the outcome of the mission was encountered.
   b. Forecast for base on take-off: Scattered stratocumulus, bases 4,000 feet, tops 6,000 feet; overcast layers, bases 10,000 feet, tops 18,000 feet; visibility 2-3 miles. Encountered: Overcast 8,000-10,000 feet, occasional breaks, intermittant light drizzle with visibility variable 3-8 miles.
   c. Forecast for target: 3/10 fair weather cumulus, 4/10 cirrus at 30,000 feet; visibility 6-8 miles. Encountered: 1st a/c over target (0436Z) reported clear, visibility unlimited. Last flight (0557Z) reported 3-6/10 cumulus, visibility unlimited.
   d. Forecast of bases on return: Stratocumulus overcast with breaks; bases 11,000 feet, tops 14,000 feet; 4/10 lower cumulus, bases 4,000, tops 7,500 feet; visibility 4 miles. Encountered: 5/10 altocumulus; visibility unlimited.

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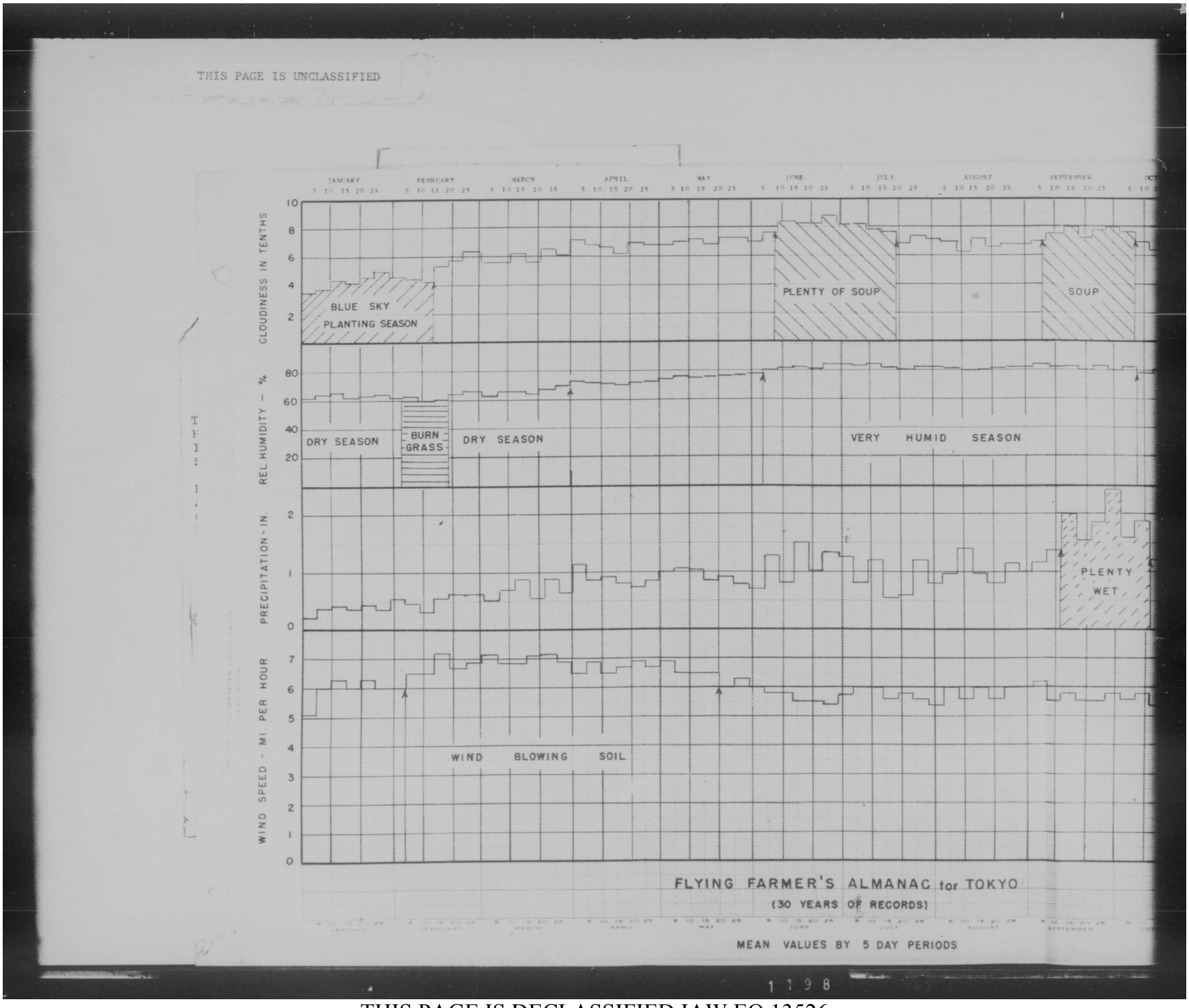




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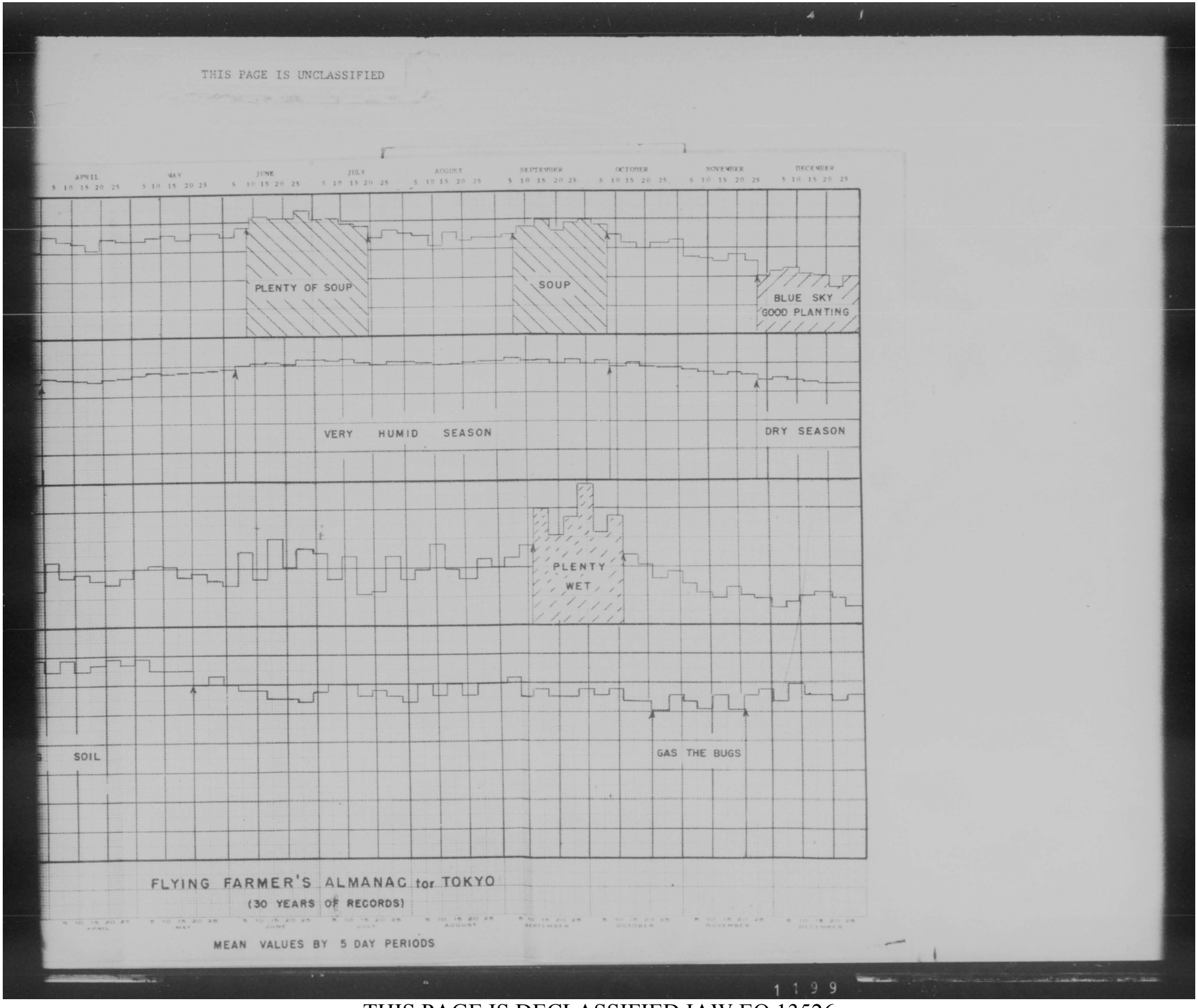




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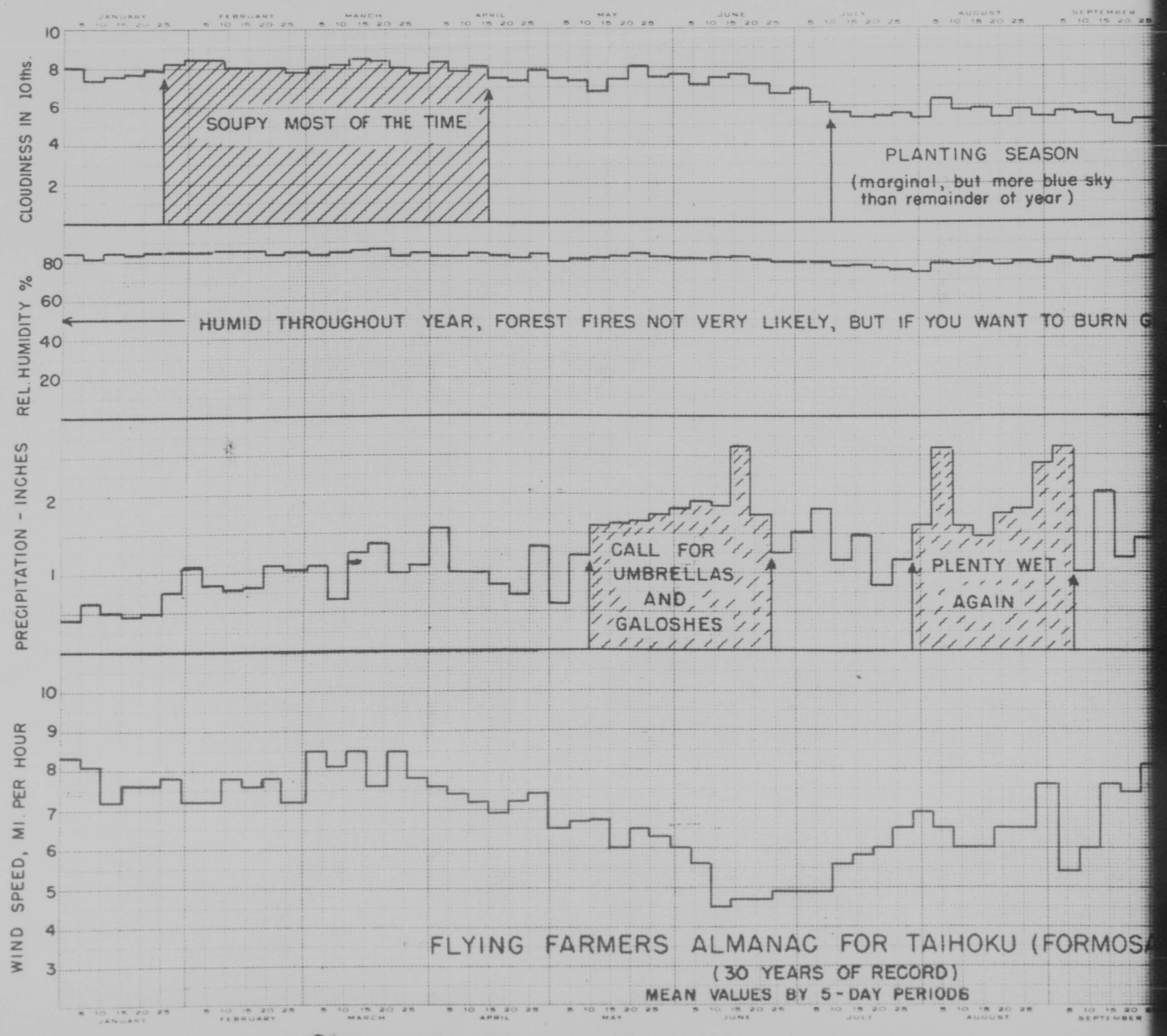


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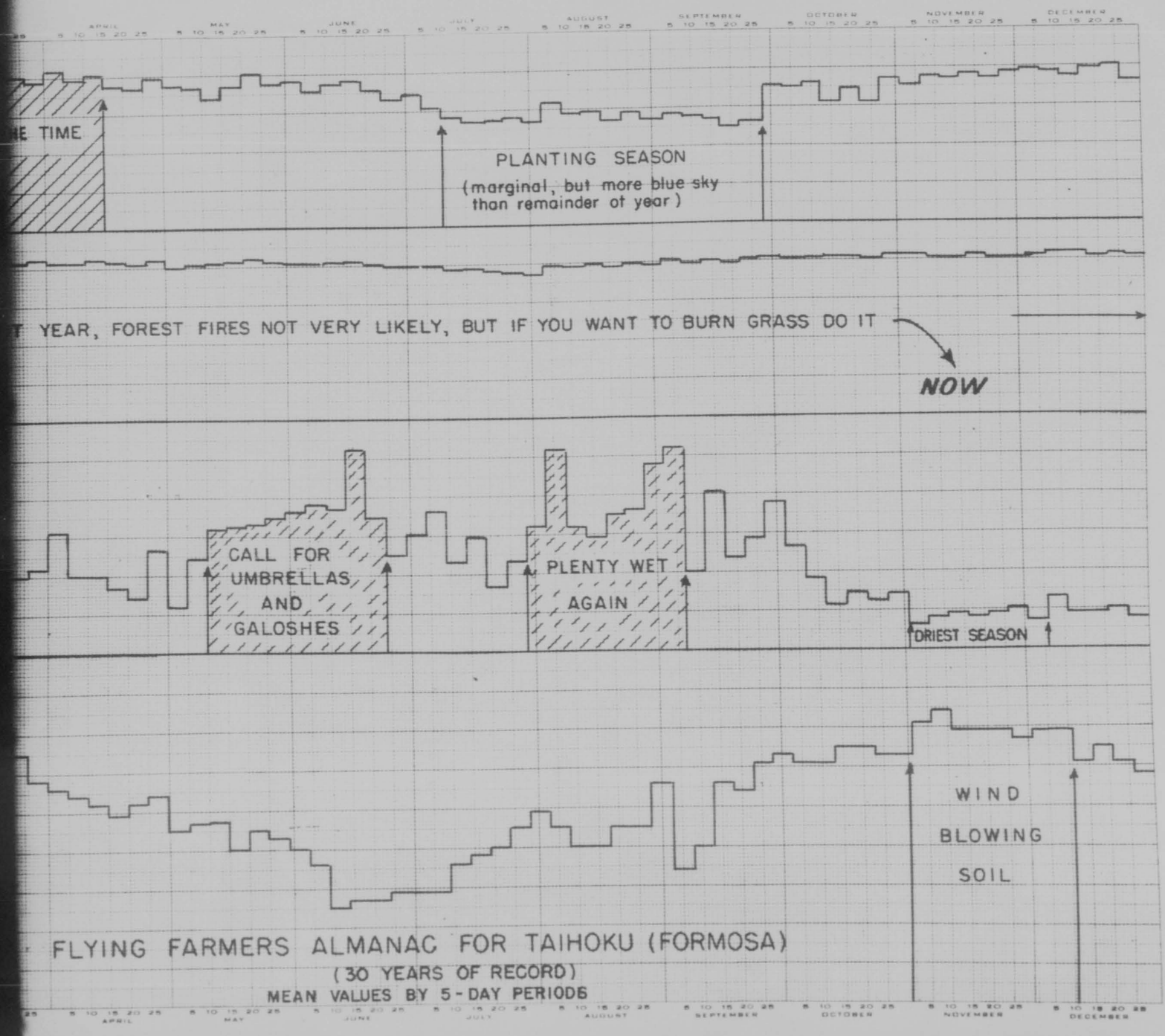




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11 May 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject : Use of Radar for Avoiding Areas of Severe Turbulance

1. Attached is a brief memorandum pointing out the usefulness of radar in preventing certain potential weather accidents. Also attached is a memorandum recently received in this headquarters from the XX Bomber Command pertinent to the above subject.

2. In view of the approaching bad weather season in the Pacific Ocean Area, attention is called to this problem.

3. I understand that a pamphlet has been prepared showing the use of radar for store detection. It is suggested that the Chief of the Training Aids Division AC/AS Training (Publication Branch) 1 park Avenue, New York City be requested to distribute, by air mail, one copy of Air Force Manual 80, entitled, "Radar Storm Protection", to each of the operating squadrons of the Twentieth Air Force. This publication is due off the press at the end of the month.

4. Authority is requested to send a copy each of the attached material to the Chief of the Weather Division AC/AS, OC & R, attention of Major Paterson and the Commanding Officer, Weather Wing. Asheville, North Carolina, Attention Dr. Kaplan, Chief, Operations Analysis Section.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

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HEADQUARTERS, TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

WASHINGTON, D. C.

20 April 1945

# WEATHER CONDITIONS IN RELATION TO INCENDIARY BOMBING OF TOKYO AREA

Report Prepared By:

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APPROVED FOR RELEASE:

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Operations Analysis Division, CST

RELEASED FOR DISTRIBUTION:

LAURIS NORSTAD,
Brigadier General, U. S. Army,
Chief of Staff, Twentieth Air Force

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# WEATHER CONDITIONS IN RELATION TO INCENDIARY BOMBING OF TOKYO AREA

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HEADQUARTERS
U. S. ARMY STRATEGIC AIR FORCES (REAR)
WASHINGTON 25, D. C.

The Pentagon - Phones 72993 & 4819
Room 3A-336

31 July 45

TO: Major General L. Norstad, Assistant Chief, Air Staff Plans OFFICE: 3E-1082
(Original to be signed by the recipient and returned to the sender.
Duplicate to be retained by the recipient addressed).

I have personally received from Capt. B. T. Tierman, Jr., Operations Analysis Division, the following classified documents as identified below. I assume full responsibility for the safe handling, storage and transmittal elsewhere of these documents in accordance with AR 380-5:

1. One (1) copy "Comment on Certain Ditching Reports", 14 June 45.

2. One (1) copy "Calibration of the B-29 Computer For Tail Defense", 4 July 45
3. One (1) copy "Modified L-6B Offset Bombing Procedure and S.O.P. For AN/APS-15 And AN/APQ-13 Equipment", 13 June 45.

4. One (1) copy "A Suggested System for Briefing B-29 Formations," 24 April 45.

5. One (1) copy "Gunnery in the B-29: The Tactical Use of Equipment", June 45

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## I. SUMMARY

1. From data obtained in the climatic area in the U. S. most comparable to the Tokyo region of Japan a useful fire weather index was obtained. Limiting conditions for "conflagration weather" are essentially as follows:

a. Relative humidities in the afternoon below 40%.

b. Cumulative rainfall on day of fire and three preceding days less than 0.01 inch.

c. Simultaneous surface wind speed more than 13 miles per hour.

2. a. Conditions outlined in paragraph 1 above occur normally on 3 to 5 days per month from January through March, in the Tokyo area.

b. Favorable fire weather conditions have almost never occurred from June to October at Tokyo. Hence incendiary raids in those months may require much greater incendiary bomb loads to achieve effects equal to those during the more favorable season.

3. Eighty (80%) per cent of the favorable days are characterized on the synoptic weather maps by

a. Absence of low pressure systems south of Japan,

b. Presence of a deep low pressure area to the E, NE or E of the Japanese islands,

c. Presence of high pressure center over northern China,

d. Intense pressure gradient with divergent flow over Japan.







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## II. OBJECTIVE OF STUDY

1. Weather is one of the important factors determining the effectiveness of incendiary bombing. The desired effect is to create a conflagration in the target area. This can be accomplished if weather conditions preceding, accompanying and succeeding the strike are favorable. The weather preceding the attack governs to a considerable extent the inflammability of materials, such as wood; the weather accompanying and immediately succeeding the strike affects the spread of fires started by incendiary bombs. If the conditions preceding the attack are unfavorable the bomb load required to start effective fires may be excessive. If the weather coincident with and subsequent to the strike is not favorable only part of the purpose may be accomplished. It was the objective of this study to determine what weather conditions can be expected to yield maximum results of incendiary raids.

## III. WHAT CONSTITUTES "FIRE WEATHER"?

1. The first task was to establish what weather conditions are likely to constitute "fire weather" in urban areas. Ideally, such a study should have been conducted with fire records from the target area and these should have been correlated to the corresponding weather observations there. Unfortunately, no day by day record of fire incidence for a Japanese city could be obtained and hence this phase of the study had to be carried on by analogy.

2. The region in the United States where weather conditions throughout the year are most nearly comparable to those in the Tokyo area is Eastern North Carolina. To be sure, there are significant differences, especially the absence of a typical sea monsoon in the summer in North Carolina, although thundershowers there during the summer result in rather similar quantities of rainfall. Yet observations in this area can give important clues with respect to the weather circumstances most favorable for the starting of fires. For this purpose the fire records for Raleigh, North Carolina, for the years 1941 to 1944 were obtained by Mr. Bond and classified according to the types of fires and time of occurrence. The type of fire that is most apt to show correlation to the weather conditions was specified in the records as "grass and rubbish fire". Assuming that the immediate causes for grass and rubbish fires, such as flying cinders, unextinguished cigarettes, etc., remain reasonably constant throughout the year, the variations show in the frequency of these fires are mainly caused by weather conditions. The primary weather factors needed to classify fire hazards are precipitation, relative humidity, and wind speed. So far as precipitation and relative humidity are concerned the conditions during the period preceding the fire are important, while in case of wind the contemporary conditions are more significant.



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3. After various trials, weighted precipitation and humidity factors were devised. These considered in addition to the day on which the fires occurred also the three preceding days. The factor for each of these elements is obtained by simply multiplying the values for the "fire day" by 4, the ones observed on the preceding day by 3, the ones before that in turn by 2 and 1. The four values obtained are then added and divided by 10.

4. a. In order to establish limiting conditions for "good fire weather" the observed frequency of grass and rubbish fires at Raleigh, North Carolina, was correlated to the humidity and precipitation factors obtained from the 1330 weather observations. In the four years for which fire records were obtained, 90 days had three or more grass and rubbish fires.

b. If these cases are tabulated according to the weighted relative humidity factor the following distribution is obtained:

| Rel. Humidity Factor % | No. of Fires Per Day 3 | 4 | 5 or more | Total 3 or more |
|---|---|---|---|---|
| 20-29 | 11 | 8 | 6 | 25 days |
| 30-39 | 19 | 4 | 15 | 38 " |
| 40-49 | 4 | 5 | 7 | 16 " |
| 50-59 | 3 | 1 | 4 | 8 " |
| 60 and more | 1 | 2 | 0 | 3 " |

It can be noted immediately that 70% of the days with 3 or more grass and rubbish fires showed a relative humidity factor of less than 40%. (Of all days only 18% have a relative humidity factor of less than 40%)

c. If the tabulation is repeated with respect to weighted precipitation the following distribution results.

| Precipitation Factor in. | No. of Fires per day 3 | 4 | 5 or more | Total 3 or more |
|---|---|---|---|---|
| 0 - T | 31 | 15 | 28 | 74 days |
| 0.01 - 0.03 | 2 | 4 | 3 | 9 " |
| 0.04 - 0.09 | 3 | 0 | 0 | 3 " |
| 0.10 and more | 2 | 1 | 1 | 4 " |

Over 80% of the cases of days with 3 or more fires per day fall into the group where the weighted precipitation factor is less than 0.01 inch. (of all the days only 37% have a precipitation factor of less than 0.01 in.)



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d. For the analysis of the wind influence only the daily maximum wind speed was available in the readily accessible weather records. The days with 5 or more fires ("conflagration days") were correlated to the maximum wind speed observed during the day with the following results.

| Max. Wind Speed mi./hr. | No. of Days With 5 or more fires. |
|---|---|
| 0 - 12 | 4 |
| 13 - 18 | 10 |
| 19 - or more | 18 |

This table indicates that on days with high fire incidence the wind speeds reach in 88% of the cases values of 13 miles per hour or more. (only 75% of all days have winds over 12 m.p.h.)

5. With the foregoing figures as a background a classification of days according to the suitability of weather conditions for the spreading of fires could be attempted. Three classes were considered sufficient for the purpose. These are:

a. Good fire days: Relative humidity factor equal or less than 40%, precipitation factor equal or less than 0.01 inch, maximum wind speed equal or more than 13 miles per hour.

b. Poor fire days:

(1) Days with relative humidity factor equal or more than 60% and precipitation factor equal or more than 0.05 inch.

(2) Days with relative humidity factor equal or more than 70%.

(3) Days with precipitation factor equal or more than 0.25 inch.

c. Indifferent fire days: All other days not included in one of the classifications under 5a and b, above. On these days weather will neither contribute much nor definitely retard fires.

6. In order to test the validity of this classification each day in the months January through April 1941 to 1944 was classified according to this scheme. The number of fires in each category of days is shown in the following table:



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| Number of Fires Per Day | Type Fire Weather Good | Indifferent | Poor |
|---|---|---|---|
| 0 | 23 | 125 | 121 |
| 1 | 32 | 59 | 21 |
| 2 | 18 | 20 | 1 |
| 3 | 17 | 3 | 3 |
| 4 and more | 20 | 17 | 0 |

On 110 good fire days 226 fires occurred, or an average of 2.05 fires per day. On 224 indifferent fire days 193 fires occurred, or an average of 0.86 fires per day, i.e., on good fire days nearly 2½ times as many fires were noted than on indifferent days. On 146 poor fire days 32 fires, or 0.22 fires per day, took place. That means the good fire days had over nine times as many fires as the poor fire days. In fact, on only 4 days did more than one fire occur if the weather conditions called for the classification "poor" and no case with 4 or more fires was noted on days with poor fire conditions. This shows that the critical limits outlined above are satisfactory to discriminate between days with weather conditions obviously influencing the pre-disposition toward fire incidence.

IV. FREQUENCY OF FIRE WEATHER AT TOKYO.

1. The next step was to apply, slightly modified in the light of readily available information, the knowledge gained from the Raleigh, North Carolina, observations to SE Honshu conditions. Ten years of daily weather data for Tokyo were available on punched cards in the Weather Division, Hq. AAF. Upon request, this material was sorted for the hour 1400 to yield the days on which simultaneously the relative humidity was 40% or less, no measurable precipitation had occurred in the past 24 hours, and the wind exceeded 10 miles per hour. The raw tabulations of the results were provided by the Weather Division, Hq. AAF, as their report No. 938. These tabulations indicate the dates on which the critical conditions had been observed and could, of course, immediately be transformed into numbers of occurrences. Also runs of several days when favorable fire weather conditions persisted could be read off the tables.

2. a. The mean number of good fire days per month, as well as the extreme number of cases in any one of the 10 years is shown in the following table.



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| No. of Days with Good Fire Weather | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 4.6 | 3.4 | 4.1 | 1.4 | 0.7 | 0.1 | 0 | 0 | 0 | 0.4 | 1.5 | 2.3 |
| Maximum | 7 | 9 | 9 | 6 | 2 | 1 | 0 | 0 | 0 | 1 | 4 | 4 |
| Minimum | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

The least number in any of the ten years was 9 days, the mean 18.5 days, the largest 28 days with good fire weather conditions.

b. Most notable from the table is the fact that there are practically no days with good fire weather conditions from June through October. The immediate consequence of this fact for incendiary bombing operations is that during those months undoubtedly greater quantities of incendiary bombs may be needed to obtain the same results as on days with "conflagration weather". The best conditions prevail in the months from January through March when 3 to 4 good fire days per month can normally be expected.

## V. FORECASTING OF FIRE WEATHER SITUATIONS

1. The tabulations of the Weather Division also offer an easy means to check the synoptic situations under which good fire weather conditions can be expected. The weather maps for all these days were examined. Unfortunately, only surface maps were available. Upper air material would have been distinctly helpful but conditions aloft had to be inferred from the surface observations. The results of the inspection of these maps may give to the forecasters some hints as to when synoptic conditions suitable for incendiary raids may be expected.

2. a. Negative cases, i.e. those with unsuitable conditions are most frequent. Synoptically they are characterized as follows: In summer weak pressure gradients and broad frontal zones with precipitation create almost completely persistent unfavorable conditions. Even during the better season, from December to April, synoptic conditions with a low pressure system south of the main Japanese islands always create adverse weather conditions.



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b. The good conditions fall into two main categories, with a slight variant to the first also creating favorable weather occasionally. These synoptic types, labelled as I, Ia and II are briefly described below.

3. a. Type I comprises about 80% of all good fire days. In this type, a deep low pressure area (developing often from a relatively stagnant and deepening wave) is located east to northeast of Honshu, usually with a cold front several hundred miles east of Tokyo. A high pressure area is located over the East Asiatic continent, usually centered in Northern China rather than in the normal Siberian position. There are no low pressure systems in the Sea of Okhotsk or the Sea of Japan. Ocassionally, there is a very weak low near Formosa. Gradients are moderate to strong. The juxtaposition of the High over China and the low to the east and northeast of Honshu creates a divergent flow pattern over Japan. Part of the air current flowing out of the high pressure system has anticyclonic curvature, the other part cyclonic curvature. With a probable high level high pressure ridge just west of Honshu, this flow will lead to dynamic subsidence and cause low surface humidities, lack of precipitation and relatively high surface wind speeds. In addition, the northwesterly surface winds associated with this pressure pattern will lead to topographic subsidence on the east coast of Honshu, because the air currents are forced to cross the mountains to the west. The dynamic and topographic subsidence effect will intensify the favorable low humidity conditions. This synoptic situation may end in several ways:

(1) The gradient of the system may weaken, often characterized by a flat extension of the Chinese high pressure system over Honshu.

(2) A low pressure center may form in the Sea of Japan and terminate the subsidence as well as the Northwest current.

(3) A low may move to the South of the Japanese islands. Occasionally an already existing weak system near Formosa may move Northeastward and end the favorable weather conditions.

b. Type Ia has most of the features of type I, except that the main low pressure system is nearly north of Honshu, often centered over Hokkaido. The winds in SE Honshu are more nearly west at the surface. This type with the Eastward migration of the low usually develops into the same synoptic pattern as type I and ends frequently by weakening gradient. Type Ia comprises about 10% of the favorable cases.



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c. Type II, also comprising about 10% of the good fire weather days, shows a deep trough through the Sea of Okhotak, the Sea of Japan into the China Sea, often with a deep closed center in the northern part of the trough. A well developed high pressure cell or ridge of high pressure is to the South or Southeast of Honshu. Isobars over Honshu run from WSW to ENE. Another High is centered over Northern China. This second High usually advances on the second day of the pattern eastward, with the major trough moving rapidly eastward, again resulting in a surface pressure distribution closely resembling Type I. The sequence usually ends with weakening gradient and wave formation in the Formosa area.

d. The clear-cut Type I also comprises the majority of the cases when good fire weather persists for several days. Some typical synoptic maps (ideal analogues) illustrating good fire weather conditions are shown at the end of the report. The forecasting of such situations, especially the divergence phenomenon and the strong gradients, creating the ideal conditions is dependant upon the availability of sufficient upper air data over most of East Asia.

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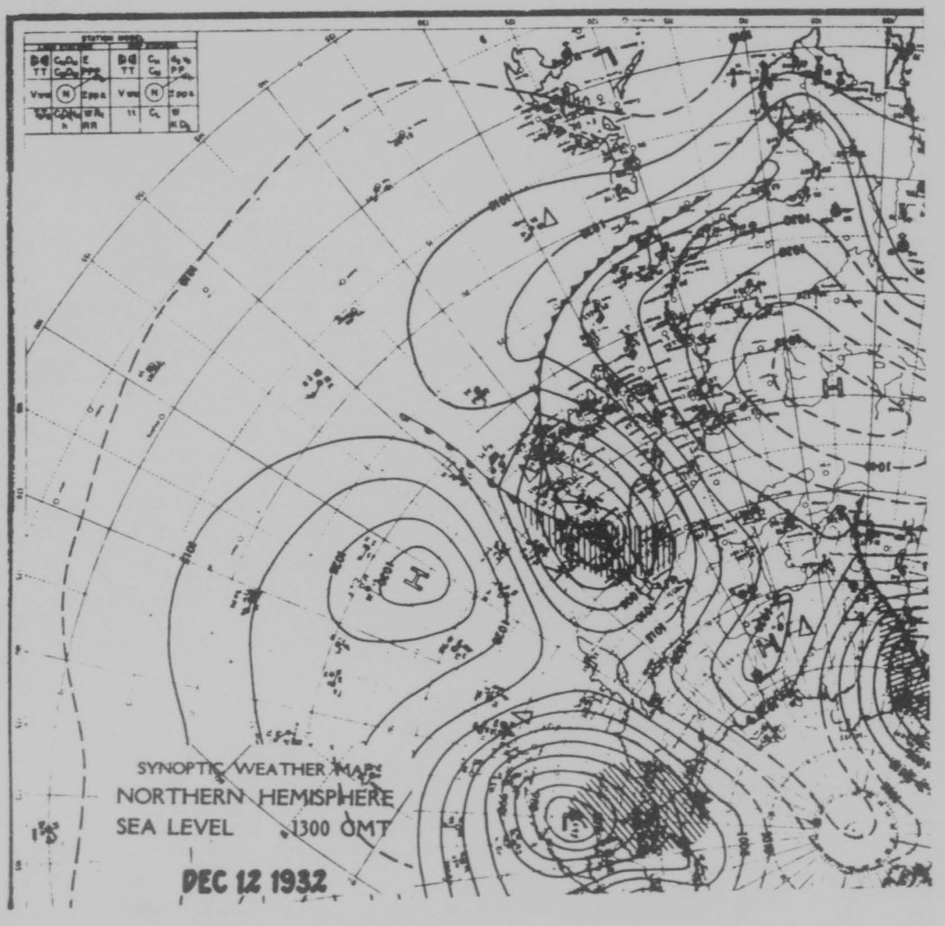




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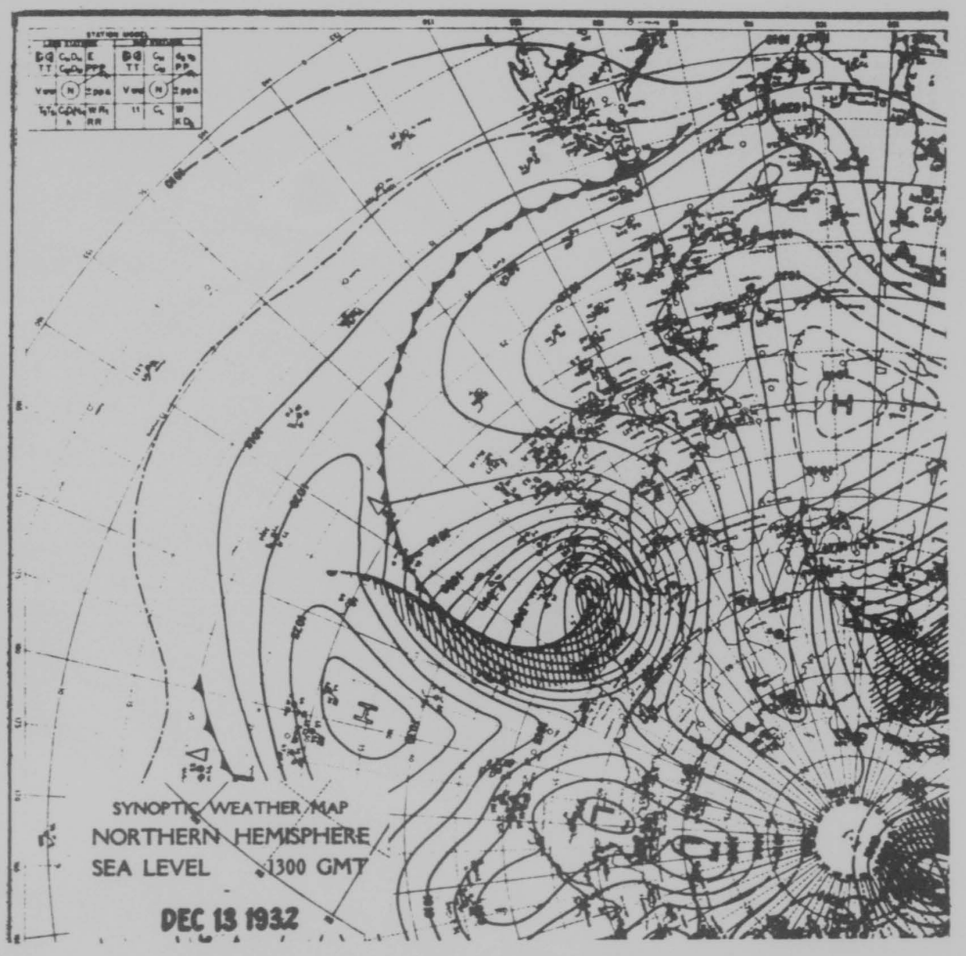


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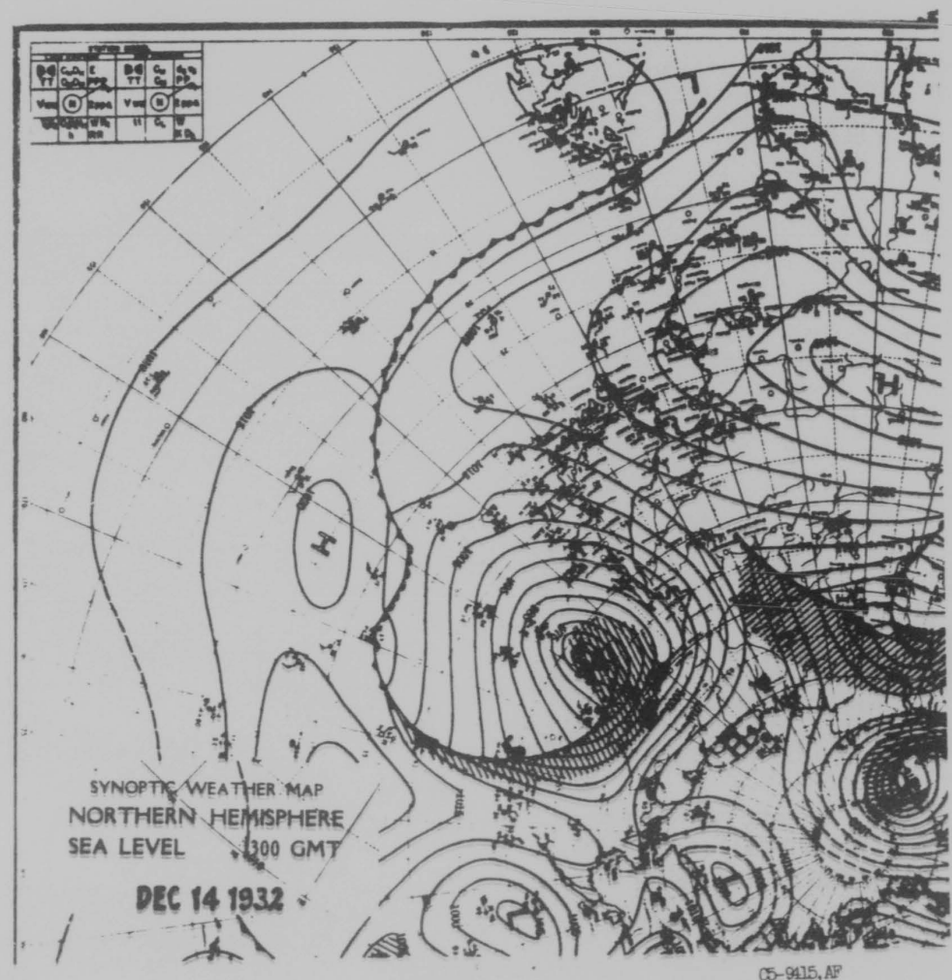




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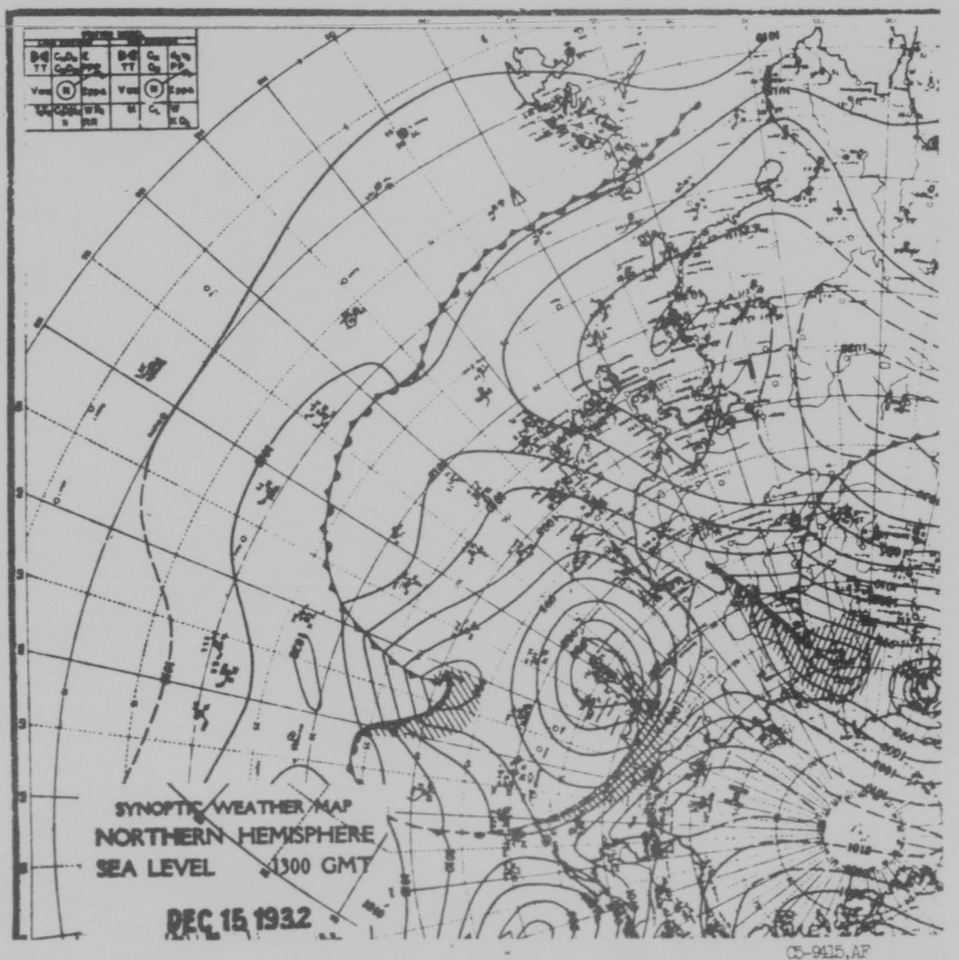




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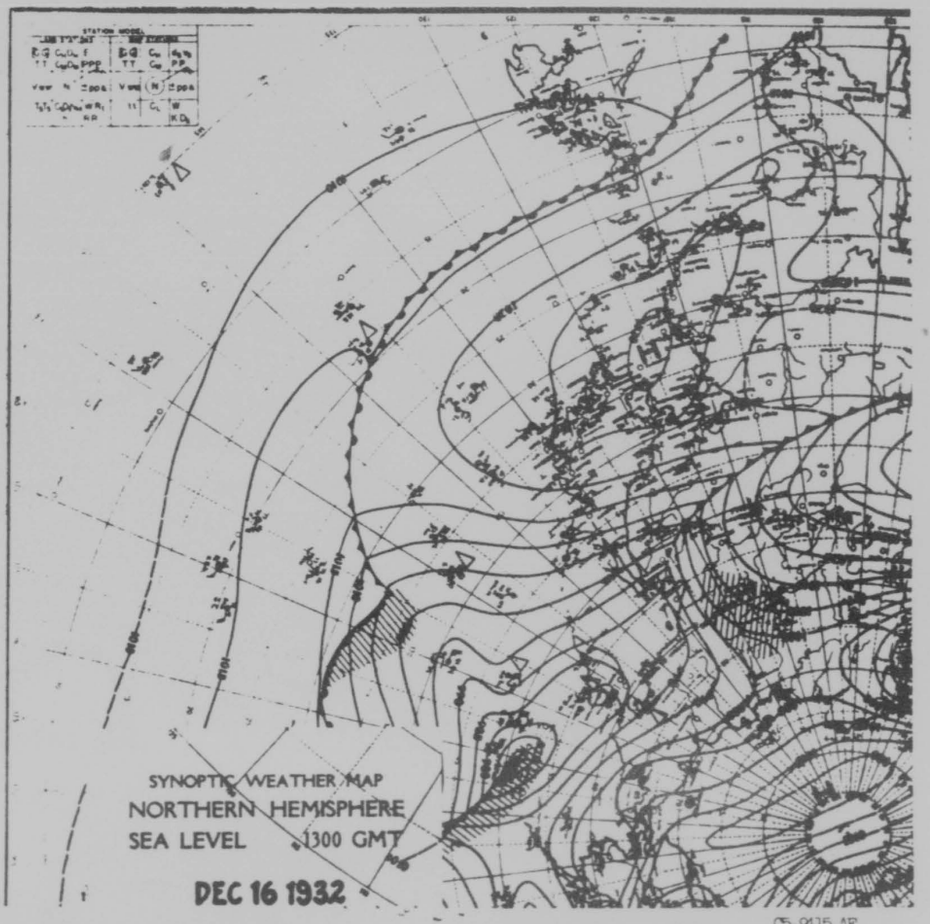


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TYPE I 12 - 17 December 1932

Map 1. Preceding Best Day By 2 - 3 Days

2. Preceding Best Day By 1 - 2 Days

3. Good Day

4. Good Day

5. Slow Deterioriation of Situation

6. Complete Deterioriation of Situation

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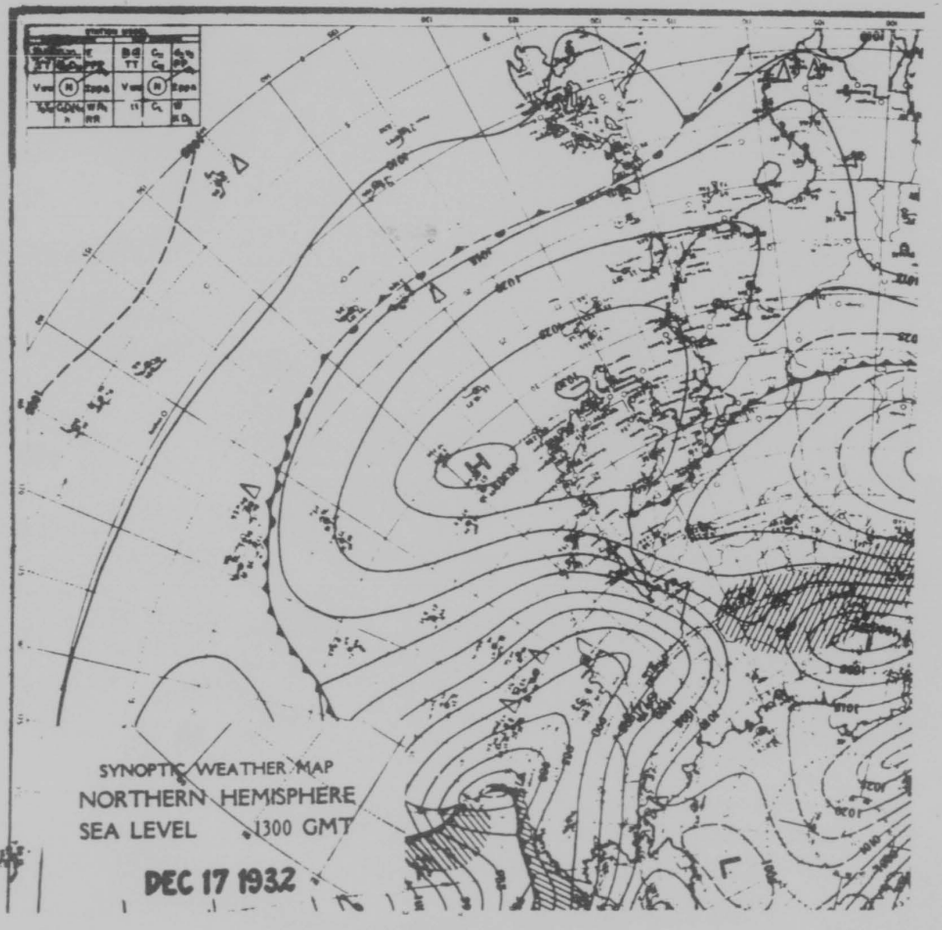


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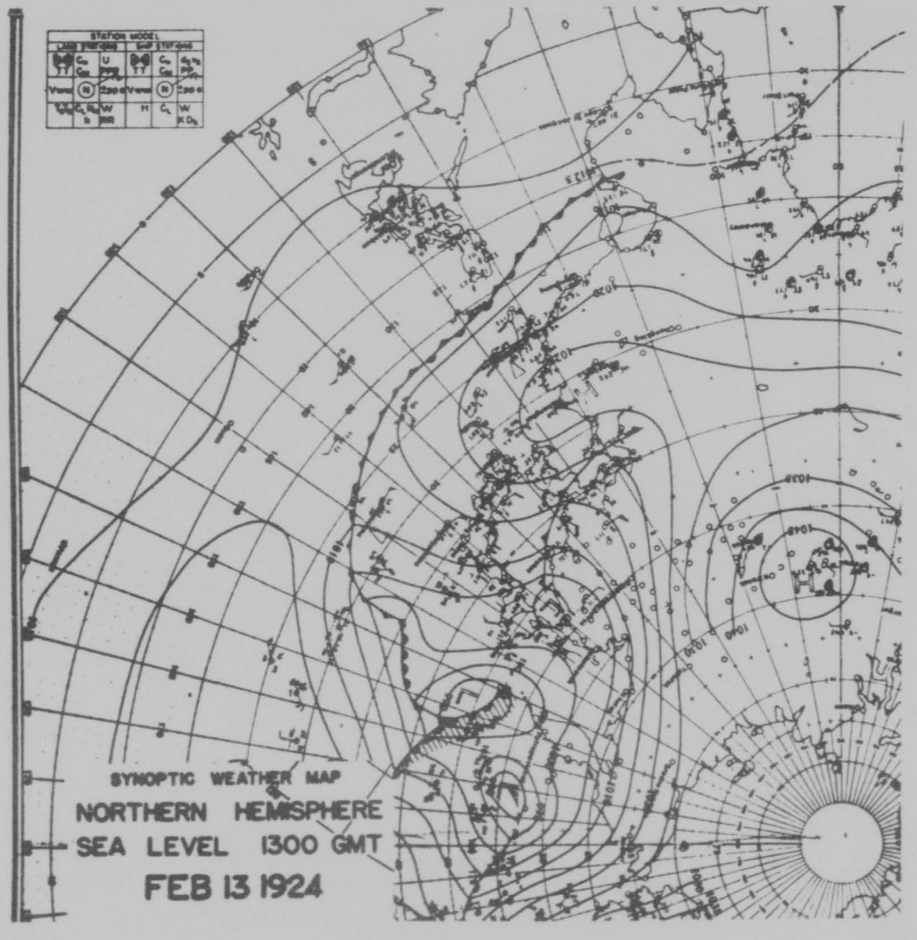




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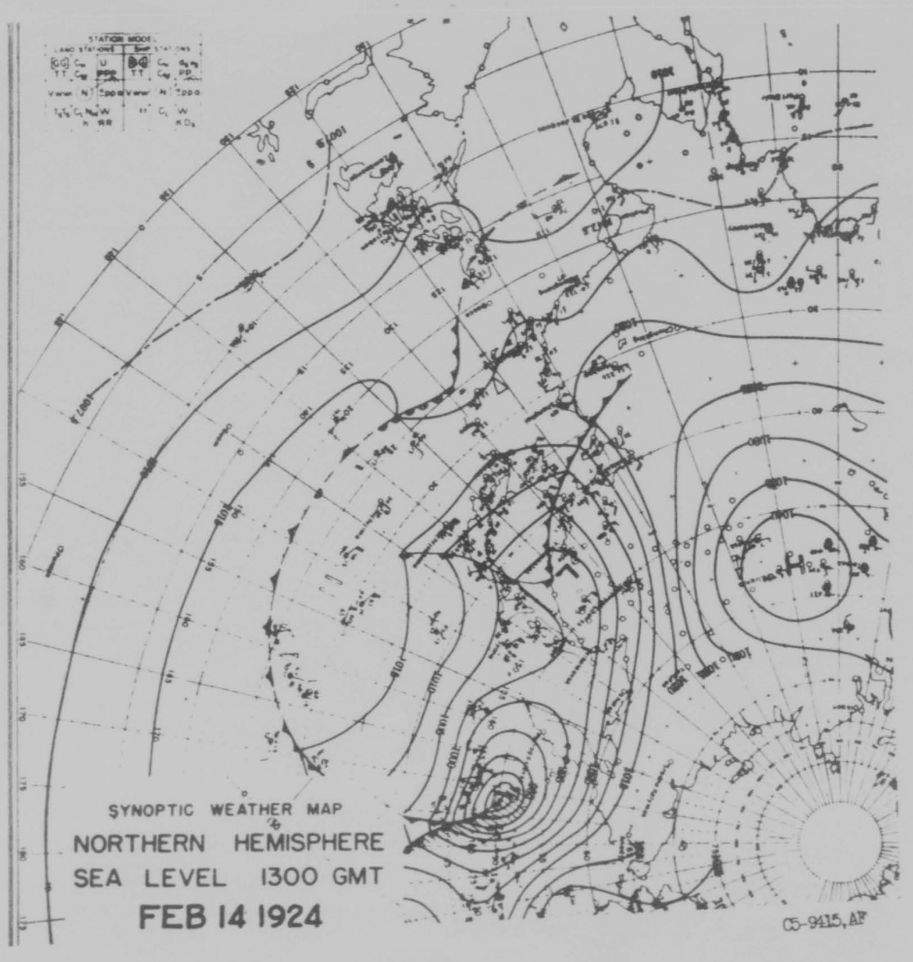




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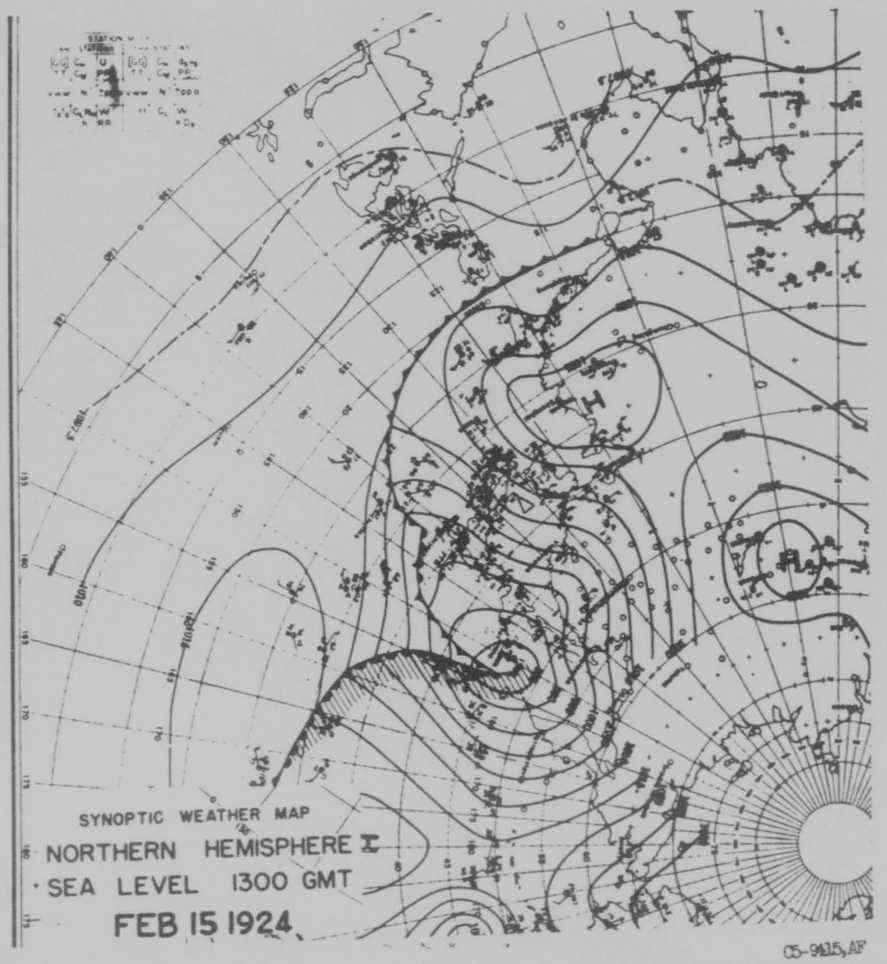




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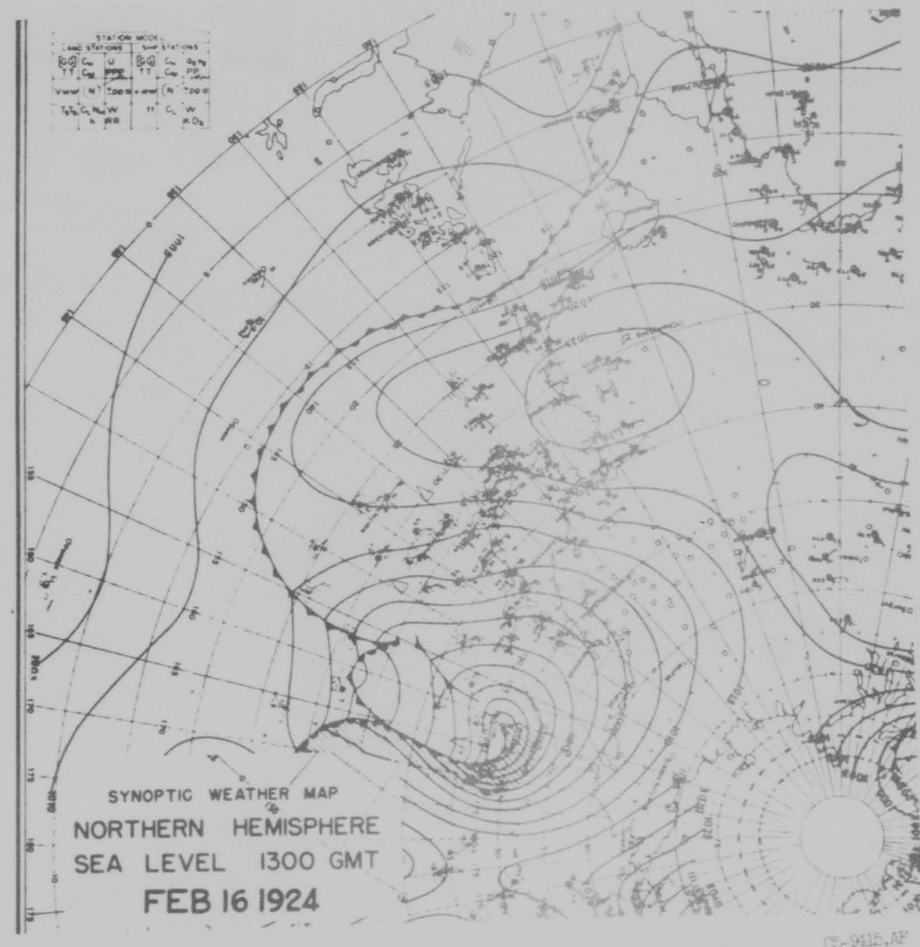




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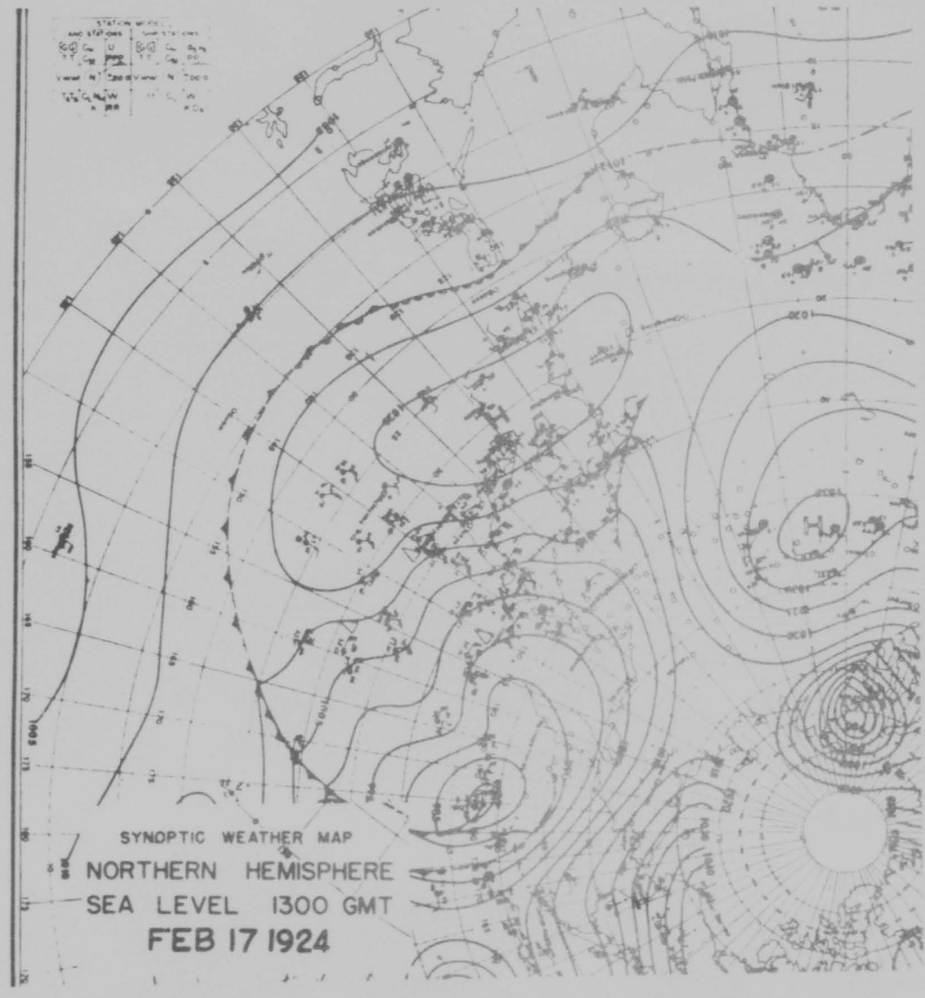




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5 January 1945.

MEMORANDUM TO MAJOR J. F. CROUTHER, JOINT TARGET GROUP.

Subject: Weather Conditions at Tokyo in August 1940.

1. In accordance with our various telephone conversations, I am giving you below the weather information for evaluation of the tests conducted on 21 August 1940:

2. The data you gave me for that day were as follows:

| Time: | Wind Dir.: | Wind Vel. M/Sec: | Temp °C: | Rel. Hum %: |
|---|---|---|---|---|
| 1300 | SSE | 2.6 | 2918 | 65 |
| 1400 | SE | 3.9 | 30.6 | 52 |
| 1500 | S | 2.8 | 31.4 | 51. |
| 1600 | S | 2.9 | 32.0 | 52 |

3. The normal values for that time of the year in Tokyo are approximately as follows:

| Time: | Wind Vel. M/Sec: | Temp °C: | Rel. Hum %: |
|---|---|---|---|
| 1300 | 3.4 | 28.5 | 66 |
| 1400 | 3.7 | 28.7 | 65 |
| 1500 | 3.9 | 28.5 | 67 |
| 1600 | 3.9 | 28.0 | 69 |

4. This means that on the day the tests in question were conducted the wind speed was about two miles per hour below normal, the relative humidity was 12% below normal and the temperature about 1.5° higher than normal for the time of the year under consideration. In my opinion this does not deviate very materially from the usual conditions, considering the very rapid changes to which weather events are subjected.

5. Since it seemed desirable to check into the weather history preceding the date of the test a search for information was made. No daily weather data for Tokyo are available in Washington for the days in question. Only the bi-daily Northern Hemisphere Weather Maps plotted by the U. S. Weather Bureau are available. These show the isobars over Japan without details on spot weather. I have examined the maps between the 16th and 21st of August 1940. My own interpretation of these maps for the Tokyo area is as follows:

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Major J. F. Crowther 5 January 1945

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It is likely that on the 17th a considerable amount of precipitation occured. After that date not much rainfall seems indicated. The 18th and 19th probably had a good deal of sunshine. The 20th was probably mostly cloudy. The relative humidities on the days preceding the tests were on an average probably above 60, but not much over 70 percent, excert for the 17th and perhaps early on the 18th when they may have been in excess of 80%.

HEL:evd

H.E. LANDSBERG,
Operations Analyst,
OAD, Twentieth Air Force.

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CST/Dr. Landsberg/rab/4819

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1 May 1945

Dr. D. M. Dennison
Department of Physics
University of Michigan
Ann Arbor, Michigan

Dear Dr. Dennison,

Inclosed you will find the results of my study of ten years of Weather Maps. Because of the available data I have somewhat deviated from the original plan and had to choose for verification of forecasts made: Tokyo, Nagasaki and Kobe. The other cities do not appear on the readily available maps. I took the years from 1927 to 1936. There is some overlap with the machine tabulation data which you will receive as soon as possible. Even in those we had to substitute two other stations for the ones desired because only 6 AM data were available for those originally desired. It seemed to me better to have two other stations where the afternoon hours were available.

Very sincerely yours,

HELMUT E. LANDSBERG

Incl:
Memo dtd 1 May 45

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CST/Dr. Landsberg/rsb/4819

1 May 1945

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SUBJECT: Study on Bombing Weather of Japan in August.

TO : Dr. D. M. Dennison
Department of Physics
University of Michigan
Ann Arbor, Michigan

1. Ten years of daily weather maps were used for the purpose of answering certain specific questions put to the undersigned recently. These years were 1927 to 1936. Available were the daily Northern Hemisphere Maps of the U. S. Weather Bureau and the daily North Pacific Weather Maps of the Marine Observatory at Kobe. The latter correspond to 1200, 135° E meridian time and are quite close to the selected target time.

2. Considered were the following items to determine a day suitable for your specific high level bombardment operation:

a. Bases in Marianas suitable for take-off and landings.

b. Route from Marianas to Japan operational.

c. One of the following three places clear in the early afternoon: Tokyo, Nagasaki, Kobe.

3. At first only strictly the available observations were tabulated and from these the number days one would have to wait for suitable conditions for each day out of the ten years were tabulated. These data are given in Table I. Wherever "0" appears beside a date that day would have been suitable for an operation.

4. Next an estimate was made, on the basis of the available weather maps, what a 24-hour forecast would have been like; the only decision to be made was whether a day was operational according to the criteria listed under paragraph 2. If the operational days which verified are again listed in a calendar and the number of days of waiting are listed the figures of Table II result.

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5. It should be noted that the estimates given as outlined in paragraph 4 are based on peace-time mans and a 24-hour lag period. How much difference there would exist under present conditions is even less than a guess. Moreover, these estimates are strictly my own. Another forecaster might arrive at different ones. I believe, however; that my estimates are reasonably conservative. In order to give you some idea of the reliability of these estimates, I am giving you below the score of the estimates for each year:

| Year | Days actually Suitable at Targets | Days Estimated Suitable at Targets | Days Not Suitable at Tgts. | Days Est. Not Suitable at Tgts. |
|---|---|---|---|---|
| 1927 | 12 | 6 | 19 | 18 |
| 8 | 14 | 10 | 14 | 13 |
| 9 | 14 | 9 | 17 | 15 |
| 1930 | 14 | 10 | 9 | 9 |
| 1 | 19 | 15 | 12 | 9 |
| 2 | 15 | 7 | 16 | 15 |
| 3 | 13 | 8 | 18 | 18 |
| 4 | 9 | 6 | 19 | 18 |
| 5 | 10 | 6 | 13 | 12 |
| 6 | 7 | 4 | 24 | 22 |

These figures exclude days when bases and routes were not operational, as it is thought that those can be forecast without serious error, provided proper reconnaissance is available. You can note that of the 127 possible days only 81 were considered forecastable, i. e. 64%; of the 161 poor days, 149 or 92% were considered clear-cut cases. This implies that at least one or two days each year during August one might expect a forecast for clear which actually turns out to be cloudy. The total score is 230 anticipated correct estimates out of a 288 or 80 per cent. This matches about the peace-time verification of 24-hour Japanese forecasts.

6. From Tables I and II the frequency distribution of waiting times for any day in August can be obtained. These distributions are as follows:

| DAYS: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CASES: | 128 | 62 | 38 | 30 | 21 | 13 | 9 | 5 | 3 | 1 | 1 | 1 |

Anticipated number of cases of waiting based on weather estimates (in ten year period)

| DAYS: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| CASES: | 82 | 42 | 38 | 29 | 23 | 18 | 14 | 11 | 11 |
| DAYS: | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CASES: | 10 | 10 | 8 | 4 | 3 | 2 | 1 | 1 | 1 |
| DAYS: | 18 | 19 | 20 | | | | | | |
| CASES: | 1 | 1 | 0 | | | | | | |

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In my opinion the anticipated waiting periods should be made basis of any planning and a pessimistic attitude be taken because of the difficulty of forecasting under war time conditions. For an important operation, I am sure, that the responsible forecaster will be utterly conservative and wait for a "sure-fire" case, if there is such.

7. Even though ten years may be too short a period to see if there is a variation of "waiting period" with respect to date in the month, not much seems to be indicated. In the actual observed cases every day in the month has been at least once a suitable day in the ten years, and even in the estimates most of the days were suitable or the waiting period was only one day. Now, as regards the maximum waiting periods, they are given below for each day, both according to observed and estimated weather conditions:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| a. | Day of Month | | | | | | 1 | 2 | 3 | 4 | 5 | 6 |
| b. | Observed Max. Waiting Period (days) | | | | | | 7 | 6 | 5 | 4 | 3 | 6 |
| c. | Max. Waiting Period from Estimates (Days) | | | | | | 11 | 10 | 9 | 14 | 13 | 12 |
| a. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | | |
| b. | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 7 | | | |
| c. | 11 | 10 | 12 | 11 | 10 | 9 | 8 | 7 | 13 | | | |
| a. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | | | |
| b. | 6 | 5 | 4 | 6 | 5 | 4 | 5 | 4 | 3 | | | |
| c. | 12 | 11 | 10 | 10 | 9 | 9 | 19 | 18 | 17 | | | |
| a. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | | | | | |
| b. | 5 | 4 | 3 | 2 | 8 | 7 | 8 | | | | | |
| c. | 16 | 15 | 14 | 13 | 12 | 11 | 10 | | | | | |

The modes of the waiting period from the actual observations is around 4-7 days, from the estimated data it is 9-12 days. These latter figures would seem to me to be pretty realistic and it should be considered that about once in ten years a forecaster might keep an important strike mission "grounded" for two weeks or longer.

8. The tenor of my comments, as you can see, is still on the pessimistic side. If you care to get an independent idea from another Meteorologist, I am glad to procure it.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

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TABLE I

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| AYB | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 6 | 0 | 2 | 0 | 0 | 7 | 0 | 0 | 0 |
| 2 | 6 | 5 | 0 | 1 | 0 | 5 | 6 | 4 | 0 | 3 |
| 3 | 5 | 4 | 0 | 0 | 0 | 4 | 5 | 3 | 0 | 2 |
| 4 | 4 | 3 | 0 | 0 | 1 | 3 | 4 | 2 | 1 | 1 |
| 5 | 3 | 2 | 1 | 2 | 0 | 2 | 3 | 1 | 0 | 0 |
| 6 | 2 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 6 | 0 |
| 7 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 5 | 11 |
| 8 | 0 | 4 | 0 | 0 | 1 | 1 | 0 | 5 | 4 | 10 |
| 9 | 1 | 3 | 0 | 5 | 0 | 0 | 1 | 4 | 3 | 9 |
| 10 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 3 | 2 | 8 |
| 11 | 0 | 1 | 3 | 3 | 3 | 0 | 1 | 2 | 1 | 7 |
| 12 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 6 |
| 13 | 4 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 2 | 5 |
| 14 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| 15 | 2 | 0 | 7 | 4 | 0 | 0 | 1 | 0 | 0 | 3 |
| 16 | 1 | 0 | 6 | 3 | 1 | 1 | 0 | 3 | 2 | 2 |
| 17 | 0 | 4 | 5 | 2 | 0 | 0 | 3 | 2 | 1 | 1 |
| 18 | 1 | 3 | 4 | 1 | 0 | 4 | 2 | 1 | 0 | 0 |
| 19 | 0 | 2 | 3 | 0 | 1 | 3 | 1 | 0 | 1 | 6 |
| 20 | 1 | 1 | 2 | 1 | 0 | 2 | 0 | 1 | 0 | 5 |
| 21 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 3 | 4 |
| 22 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 2 | 3 |
| 23 | 1 | 0 | 3 | 0 | 1 | 4 | 0 | 4 | 1 | 2 |
| 24 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 3 | 0 | 1 |
| 25 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 5 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 4 | 3 |
| 27 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 3 | 2 |

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TABLE I (CONTINUED)

| DATE | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 |
|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 2 | 1 |
| 29 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 8 | 1 | 0 |
| 30 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 7 | 0 | 0 |
| 31 | 2 | 2 | 1 | 1 | 5 | 1 | 0 | 6 | 0 | 2 |

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TABLE II

| DATE | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 11 | 0 | 3 | 0 | 6 | 11 | 0 | 0 | 5 |
| 2 | 10 | 10 | 0 | 2 | 0 | 5 | 10 | 4 | 0 | 4 |
| 3 | 9 | 9 | 0 | 1 | 0 | 4 | 9 | 3 | 0 | 3 |
| 4 | 8 | 8 | 2 | 0 | 2 | 3 | 8 | 2 | 14 | 2 |
| 5 | 7 | 7 | 1 | 2 | 1 | 2 | 7 | 1 | 13 | 1 |
| 6 | 6 | 6 | 0 | 1 | 0 | 1 | 6 | 0 | 12 | 0 |
| 7 | 5 | 5 | 0 | 0 | 0 | 0 | 5 | 6 | 11 | 11 |
| 8 | 4 | 4 | 0 | 0 | 1 | 1 | 4 | 5 | 10 | 10 |
| 9 | 3 | 3 | 0 | 12 | 0 | 0 | 3 | 4 | 9 | 9 |
| 10 | 2 | 2 | 4 | 11 | 0 | 5 | 2 | 3 | 8 | 8 |
| 11 | 1 | 1 | 3 | 10 | 4 | 4 | 1 | 2 | 7 | 7 |
| [illegible] | 0 | 0 | 2 | 9 | 3 | 3 | 0 | 1 | 6 | 6 |
| 13 | 6 | 0 | 1 | [illegible] | 2 | 2 | 3 | 0 | 5 | 5 |
| 14 | 5 | 0 | 0 | 7 | 1 | 1 | 2 | 0 | 4 | 4 |
| 15 | 4 | 1 | 13 | 6 | 0 | 0 | 1 | 0 | 3 | 3 |
| 16 | 3 | 0 | 12 | 5 | 2 | 6 | 0 | 5 | 2 | 2 |
| 17 | 2 | 4 | 11 | 4 | 1 | 5 | 5 | 4 | 1 | 1 |
| 18 | 1 | 3 | 10 | 3 | 0 | 4 | 4 | 3 | 0 | 0 |
| 19 | 0 | 2 | 9 | 2 | 1 | 3 | 3 | 2 | 1 | 10 |
| 20 | 1 | 1 | 8 | 1 | 0 | 2 | 2 | 1 | 0 | 9 |
| 21 | 0 | 0 | 7 | 0 | 0 | 1 | 1 | 0 | 9 | 8 |
| 22 | 3 | 0 | 6 | 0 | 0 | 0 | 0 | 19 | 8 | 7 |
| 23 | 2 | 0 | 5 | 0 | 3 | 4 | 0 | 18 | 7 | 6 |
| 24 | 1 | 0 | 4 | 0 | 2 | 3 | 0 | 17 | 6 | 5 |
| [illegible] | 0 | 0 | 3 | 0 | 1 | 2 | 0 | 16 | 5 | 4 |
| 26 | 0 | 0 | 2 | 0 | 0 | 1 | 3 | 15 | 4 | 3 |

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TABLE II (CONTINUED)

| DATE | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 |
|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 0 | 6 | 1 | 2 | 2 | 0 | 2 | 14 | 3 | 2 |
| 28 | 10 | 5 | 0 | 1 | 1 | 0 | 1 | 13 | 2 | 1 |
| 29 | 9 | 4 | 1 | 0 | 0 | 0 | 0 | 12 | 1 | 0 |
| 30 | 8 | 3 | 0 | 2 | 0 | 3 | 0 | 11 | 0 | 0 |
| 31 | 7 | 2 | 2 | 1 | 7 | 2 | 1 | 10 | 8 | 2 |

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20 April 1945

[illegible]

Subject: Weather Information for Tokyo.

1. Given below are the mean values of cloudiness and precipitation values, obtained from ten years of records for Tokyo, recently requested by you:

| Month | Hour | Mean No. of Days Cloudiness 7-10/10 | No. Days with Simultaneous Precipitation |
|---|---|---|---|
| June | 1500 | 23.8 | 7.5 |
| | 1600 | 23.2 | 7.3 |
| | 1700 | 22.5 | 4.9 |
| | 1800 | 23.7 | 7.4 |
| July | 1500 | 21.5 | 6.9 |
| | 1600 | 20.9 | 7.1 |
| | 1700 | 21.5 | 4.9 |
| | 1800 | 23.5 | 7.3 |
| August | 1500 | 17.9 | 5.2 |
| | 1600 | 17.5 | 4.6 |
| | 1700 | 19.4 | 4.3 |
| | 1800 | 20.3 | 5.3 |

2. The other information on clear days is as follows:

Number of Days With Mean Daily Cloudiness Equal to or Less Than 2/10ths at Tokyo

| Year | June | July | August |
|---|---|---|---|
| 1923 | 1 | 1 | 1 |
| 1924 | 1 | 2 | 1 |
| 1925 | 0 | 2 | 0 |
| 1926 | 3 | 0 | 1 |
| 1927 | 0 | 0 | 2 |
| 1928 | 0 | 1 | 1 |
| 1929 | 0 | 2 | 0 |
| 1930 | 0 | 0 | 0 |
| 1931 | 1 | 0 | 3 |
| 1932 | 0 | 1 | 1 |
| 1938 | 3 | 0 | 0 |

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The mean cloud amount for the day is based upon hourly observations taken from 0600 to 2200 135th East Meridian Time inclusive.

The source of the data is the Japanese Monthly Meteorological Bulletin.

[redacted]
Operations Analyst
Twentieth Air Force

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PREFACE

The following report prepared at the request of the Twentieth Air Force, contains the results obtained in a climatological study of the winds over Tsteno, Japan, undertaken in an effort to find an approximation to the ballistic wind knowing only the wind at bombing altitude. There is now in progress a project (No. Q4483) of the AAF Board to determine methods of putting into the bombsight corrections for the ballistic wind in order to eliminate the errors caused in present bombing procedure by ignoring the ballistic wind. Data for this report were taken from Weather Division punched card summaries. The report presents only the results of the climatological study, outlining a method of finding a good approximation to the ballistic wind, but makes no attempt to tell how that wind should be used once it has been determined.

Information furnished is in answer to the request, and the Weather Division, Headquarters Army Air Forces, assumes no responsibility for further interpretations made without its concurrence.

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# COMPUTATION OF APPROXIMATE BALLISTIC WINDS AND DIFFERENTIAL BALLISTIC WINDS OVER JAPAN BY USE OF THE WIND AT BOMBING ALTITUDE

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This statistical study was made of the winds at Tateno, Japan, in an attempt to find a good approximation to the ballistic wind, knowing only the wind at bombing altitude. The study was based on upper air observations at Tateno for the years 1929-1936.

The analysis was begun by computing the ballistic winds for the levels 9,842, 19,685, 26,246, and 32,808 feet for each wind run which attained any of those levels. The data was then broken up by seasons, using January, February, and March for winter; April, May, and June for spring; July, August, and September for summer; and October, November and December for autumn.

It was decided to approximate the ballistic wind by a wind in the same direction as that at bombing altitude. An equation of the form

$$W_B = AW + B$$

was worked out, where

$W_B$ = speed of approximate ballistic wind

$W$ = speed of wind at bombing altitude.

The coefficients A and B were chosen to minimize the vector difference between the true ballistic wind and the approximation $W_B$. Such an equation was worked out for each season and each of the four levels mentioned above. This method of approximation proved satisfactory, since the standard errors were small.

The foregoing process gave a total of sixteen values for A and sixteen for B, one for each of four seasons and for each of four levels. Values





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of A and B for each season for the levels 10,000, 15,000, 20,000, 25,000, 30,000 and 35,000 feet were found by interpolation. Since, in order to simplify the analysis, the ballistic winds were all computed using the same weighting factor curve regardless of ground speed or bombing altitude, corrections were applied to the computed values of A and B by taking into account the variation of the weighting factor curve with altitude and ground speed. The results were then gathered into the two accompanying tables.

Table 1 gives values of the constants A and B for computing the ballistic wind from the equation

$$W_B = AW + B.$$

In order to use this table, the wind at bombing altitude and the ground speed must be determined first. The table is entered with the proper season, ground speed, and elevation, and the corresponding values of A and B are read off. The wind at bombing altitude is multiplied by A and the result is added to B to give the approximate ballistic wind. This wind is in the same direction as the wind at bombing altitude.

The following example will illustrate the process described above.

DATE: 23 Apr

BOMBING ALTITUDE: 20,000'

WIND AT ALTITUDE: 270° at 50mph

GROUND SPEED: 400 mph

Entering the table with spring for the season, 400mph for the ground speed, and 20,000 feet for the bombing altitude, the values of A and B are

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found to be

$$A = 0.64$$

$$B = 0.$$

Hence

$$W'_B = 0.64 \times 50 \quad 0 = 32 \text{ mph}$$

Table 2 is used in exactly the same way as Table 1 except that it gives the differential ballistic wind instead of the ballistic wind according to the formula

$$\Delta W_B = B - CW$$

where

$\Delta W_B$ = differential ballistic wind.

Using the same bombing problem as in the last example, the values of B and C are

$$B = C$$

$$C = 0.36.$$

Therefore,

$$\Delta W_B = 0.36 \times 50 = -18 \text{mph}$$

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TABLE 1

Constants for Computing Approximate Ballistic Wind from Wind at Bombing Altitude for Tateno, Japan. $W_B = AW_B$ ( $W_B$ = approximate ballistic wind in mph; $W_B$ = wind at bombing altitude in mph).

| Season | Ground Speed (mph) | | Bombing Altitude (ft.) 10,000 | 15,000 | 20,000 | 25,000 | 30,000 | 35,000 |
|---|---|---|---|---|---|---|---|---|
| WINTER (Jan., Feb., Mar.) | 100 | A | 0.68 | 0.62 | 0.56 | 0.51 | 0.42 | 0.33 |
| | | B | 1 | 4 | 7 | 6 | 11 | 15 |
| | 200 | A | 0.72 | 0.64 | 0.58 | 0.53 | 0.44 | 0.35 |
| | | B | 1 | 4 | 7 | 7 | 12 | 16 |
| | 300 | A | 0.72 | 0.65 | 0.59 | 0.54 | 0.45 | 0.36 |
| | | B | 1 | 4 | 8 | 7 | 12 | 16 |
| | 400 | A | 0.72 | 0.66 | 0.59 | 0.55 | 0.46 | 0.38 |
| | | B | 1 | 4 | 8 | 7 | 13 | 17 |
| | 500 | A | 0.73 | 0.66 | 0.59 | 0.56 | 0.49 | 0.40 |
| | | B | 1 | 4 | 8 | 7 | 13 | 18 |
| SPRING (Apr., May, June) | 100 | A | 0.71 | 0.66 | 0.60 | 0.52 | 0.44 | 0.37 |
| | | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | 200 | A | 0.75 | 0.68 | 0.63 | 0.54 | 0.46 | 0.40 |
| | | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | 300 | A | 0.75 | 0.69 | 0.64 | 0.55 | 0.48 | 0.41 |
| | | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | 400 | A | 0.75 | 0.70 | 0.64 | 0.56 | 0.49 | 0.42 |
| | | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | 500 | A | 0.76 | 0.70 | 0.64 | 0.58 | 0.52 | 0.45 |
| | | B | 0 | 0 | 0 | 1 | 3 | 4 |

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TABLE 1 (Continued)

| Season | Ground Speed (mph) | | Bombing Altitude (ft.) 10,000 | 15,000 | 20,000 | 25,000 | 30,000 | 25,000 |
|---|---|---|---|---|---|---|---|---|
| SUMMER (July, Augl, Sept.) | 100 | A | 0.74 | 0.69 | 0.63 | 0.57 | 0.51 | 0.45 |
| | | B | 0 | 0 | 0 | 1 | 2 | 2 |
| | 200 | A | 0.78 | 0.71 | 0.66 | 0.60 | 0.53 | 0.48 |
| | | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | 300 | A | 0.78 | 0.72 | 0.67 | 0.61 | 0.55 | 0.50 |
| | | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | 400 | A | 0.78 | 0.73 | 0.67 | 0.62 | 0.56 | 0.52 |
| | | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | 500 | A | 0.79 | 0.73 | 0.67 | 0.64 | 0.60 | 0.55 |
| | | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | 100 | A | 0.69 | 0.63 | 0.57 | 0.50 | 0.46 | 0.42 |
| | | B | 0 | 0 | 1 | 3 | 5 | 5 |
| | 200 | A | 0.73 | 0.66 | 0.60 | 0.53 | 0.48 | 0.45 |
| | | B | 0 | 0 | 1 | 4 | 5 | 5 |
| | 300 | A | 0.73 | 0.66 | 0.61 | 0.54 | 0.49 | 0.47 |
| | | B | 0 | 0 | 1 | 4 | 5 | 6 |
| | 400 | A | 0.73 | 0.67 | 0.61 | 0.55 | 0.51 | 0.48 |
| | | B | 0 | 0 | 1 | 4 | 5 | 6 |
| | 500 | A | 0.74 | 0.68 | 0.61 | 0.56 | 0.54 | 0.52 |
| | | B | 0 | 0 | 1 | 4 | 6 | 6 |

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TABLE 2

Constants for Computing Approximate Differential Ballistic Wind From Wind at Bombing Altitude for Tateno, Japan. $W_B = B - CW$ ($W_B$ = approximate differential ballistic wind in mph; W = wind at bombing altitude in mph)

| Season | Ground Speed (mph) | | Bombing Altitude (ft.) 10,000 | 15,000 | 20,000 | 25,000 | 30,000 | 35,000 |
|---|---|---|---|---|---|---|---|---|
| WINTER (Jan., Feb., Mar.) | 100 | B | 1 | 4 | 7 | 6 | 11 | 15 |
| | | C | 0.32 | 0.38 | 0.44 | 0.49 | 0.58 | 0.67 |
| | 200 | B | 1 | 4 | 8 | 7 | 12 | 16 |
| | | C | 0.29 | 0.36 | 0.42 | 0.47 | 0.56 | 0.65 |
| | 300 | B | 1 | 4 | 8 | 7 | 12 | 16 |
| | | C | 0.28 | 0.35 | 0.41 | 0.46 | 0.55 | 0.64 |
| | 400 | B | 1 | 4 | 8 | 7 | 13 | 16 |
| | | C | 0.28 | 0.34 | 0.41 | 0.45 | 0.54 | 0.62 |
| | 500 | B | 1 | 4 | 8 | 7 | 12 | 18 |
| | | C | 0.27 | 0.34 | 0.41 | 0.44 | 0.51 | 0.60 |
| | 100 | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | | C | 0.29 | 0.34 | 0.40 | 0.48 | 0.56 | 0.63 |
| | 200 | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | | C | 0.25 | 0.32 | 0.37 | 0.46 | 0.54 | 0.60 |
| | 300 | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | | C | 0.25 | 0.31 | 0.36 | 0.45 | 0.52 | 0.59 |
| | 400 | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | | C | 0.25 | 0.30 | 0.36 | 0.44 | 0.51 | 0.58 |
| | 500 | B | 0 | 0 | 0 | 1 | 3 | 4 |
| | | C | 0.24 | 0.30 | 0.36 | 0.42 | 0.49 | 0.55 |

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TABLE 2 (Continued)

| Season | Ground Speed (mph) | | Bombing Altitude (ft.) 10,000 | 15,000 | 20,000 | 25,000 | 30,000 | 35,000 |
|---|---|---|---|---|---|---|---|---|
| SUMMER (July, Aug., Sept.) | 100 | B | 0 | 0 | 0 | 1 | 2 | 2 |
| | | C | 0.26 | 0.31 | 0.37 | 0.43 | 0.49 | 0.55 |
| | 200 | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | | C | 0.22 | 0.29 | 0.34 | 0.40 | 0.47 | 0.52 |
| | 300 | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | | C | 0.22 | 0.29 | 0.33 | 0.39 | 0.45 | 0.50 |
| | 400 | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | | C | 0.22 | 0.27 | 0.33 | 0.38 | 0.44 | 0.48 |
| | 500 | B | -1 | 0 | 0 | 1 | 2 | 2 |
| | | C | 0.21 | 0.27 | 0.33 | 0.36 | 0.42 | 0.45 |
| AUTUMN (Oct., Nov., Dec.) | 100 | B | 0 | 0 | 1 | 3 | 5 | 5 |
| | | C | 0.31 | 0.37 | 0.43 | 0.50 | 0.54 | 0.58 |
| | 200 | B | 0 | 0 | 1 | 4 | 5 | 5 |
| | | C | 0.27 | 0.34 | 0.40 | 0.47 | 0.52 | 0.55 |
| | 300 | B | 0 | 0 | 1 | 4 | 5 | 6 |
| | | C | 0.27 | 0.34 | 0.39 | 0.46 | 0.51 | 0.53 |
| | 400 | B | 0 | 0 | 1 | 4 | 5 | 6 |
| | | C | 0.27 | 0.33 | 0.39 | 0.45 | 0.49 | 0.52 |
| | 500 | B | 0 | 0 | 1 | 4 | 6 | 6 |
| | | C | 0.26 | 0.32 | 0.38 | 0.44 | 0.46 | 0.48 |

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HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D. C.

1 March 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION.

Subject: Ballistic Winds Over Japan.

1. Some telecon correspondence has been going on between OC&R Bombardment Branch and the Headquarters of the XX Bomber Command with regard to Ballistic Winds. References are telecon E-2-1 from this Headquarters and telecon E-1809, dated 22 February 1945, from DEPCOMAF 20 I B & C.

2. It was suggested to use 30% of the wind observed at bombing altitude as differential ballistic wind but the XX Bomber Command questioned the suitability of this factor because of latitudinal and Seasonal variations.

3. The research section of the Weather Division (Captain Porter) has made a study of the ballistic winds and from recent results obtained the following paragraphs are quoted:

a. Study was based on data of observed winds collected over Honshu. In the attached table "Upper Air Winds for Japan" the mean winds and the differential ballistic winds are shown. These are the ordinary arithmetic average of the observational data.

b. The probable maximum winds are differential ballistic winds are the highest observed in the available Japanese data. In this connection, it should be borne in mind that these data are from pilot balloon ascents tracked visually by a thheodolite. Therefore, somewhat greater maximum velocities may be anticipated to occur because high winds in all layers of the atmosphere will blow the balloon beyond the visual range of the observer. Also, high winds are often associated with poor visibilities and low ceilings, making visual wind determination impossible.

c. The absolute maximum winds and differential ballistic winds are estimated from the probable maxima described in paragraph 3 b, above, and their magnitude is based on operational flight reports.

d. The prevailing wind direction for all seasons and all altitudes to the nearest point of a sixteen - point compass is west.

e. Studies on other target areas are still in progress.

4. In view of the fact that the Operations Analysis Sections in the field with the XX and XXI Bomber Commands may be confronted with problems concerning ballistic winds it is suggested that a copy of this letter and the attached table be sent to these Sections for ready reference.

1 Incl - Table "Upper Air Winds for Japan".

H. E. LANDSBERG,
Operations Analyst.

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## UPPER AIR WINDS FOR JAPAN

| Level | Season | Actual Winds (mph) Observed at Indicated Levels | | | Differential Ballistic Winds (mph) from Indicated Levels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Absolute Maximum | Probable Maximum | Mean | Absolute Maximum | | Probable Maximum | | Mean | |
| 10 Kilometers | Winter | 370 | 202 | 115 | 200 | 59% | 105 | 52% | 46 | 40% |
| | Spring | 290 | 159 | 59 | 160 | 56% | 83 | 52% | 23 | 39% |
| | Summer | 270 | 148 | 31 | 140 | 52% | 72 | 49% | 10 | 32% |
| | Autumn | 390 | 207 | 106 | 200 | 52% | 107 | 52% | 45 | 42% |
| 8 Kilometers | Winter | 250 | 136 | 73 | 70 | 28% | 35 | 26% | 25 | 34% |
| | Spring | 230 | 125 | 39 | 90 | 39% | 48 | 38% | 15 | 38% |
| | Summer | 130 | 68 | 25 | 50 | 38% | 23 | 34% | 7 | 28% |
| | Autumn | 300 | 163 | 72 | 120 | 40% | 64 | 39% | 30 | 42% |
| 6 Kilometers | Winter | 220 | 118 | 55 | 100 | 45% | 50 | 42% | 18 | 33% |
| | Spring | 150 | 79 | 29 | 50 | 33% | 24 | 30% | 12 | 41% |
| | Summer | 130 | 70 | 21 | 50 | 38% | 27 | 39% | 6 | 29% |
| | Autumn | 220 | 112 | 47 | 70 | 32% | 37 | 33% | 18 | 26% |

NOTE: Table was slightly changed from original prepared by Weather Division to include the percentages of the differential ballistic winds in terms of the observed. Comments (by OAD): as can be seen especial especially at high observed wind speeds the differential ballistic wind is higher than the 30% value recommended by OC&R bombardment. The seasonal variation indicated is not very uniform, although it seems that for the mean wind summer has the lowest value for the differential ballistic wind and also approaches the 30% value most closely and consistently at all levels.

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CST/H.E. Landsberg/rab/4819

25 May 1945

MEMORANDUM FOR LT. COLONEL W. F. SAVOIE, DC OF S, COMBAT OPERATIONS
ROOM NO. 4E-188

Subject: Hurricane Evacuation Scheme for Okinawa Air Bases.

1. If no special plans for hurricane evacuation for Okinawa bases have been made it would seem essential to formulate such plans at any early moment.

2. The Ryukyu Islands are subjected quite regularly each year to hurricanes (typhoons) of varying intensity. The pertinent meteorological statistics are given in paragraph 3 below.

3. a. Maximum wind velocity on record at Naha during a period of thirty-nine (39) years has been 101 miles per hour.

b. The mean monthly distribution of typhoons in that area is as follows, (40 years of record):

| May | June | July | August | September | October | November | Year |
|---|---|---|---|---|---|---|---|
| 0.1 | 0.2 | 0.6 | 1.5 | 1.0 | 0.6 | 0.2 | 4.2 |

c. Of the average of 4.2 cases per year, 1.1 had wind velocities between 32 to 54 miles per hour, 2.1 had 55-75 miles per hour, 1.0 had 76 or more miles per hour.

d. Out of the 40 years on record, all had at least one typhoon per year, two years had as many as 9 cases. 27 years had between 3 and 5 cases of typhoons, per year. The mean value of 4 per year is therefore a very representative figure; one of these can normally be expected to have velocities of 76 miles per hour or more.

HELMUT E. LANDSBERG
Operations Analyst
Twentieth Air Force

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MEMORANDUM TO: Colonel, E. E. Aldrin

FROM: Dr. H. E. Landsberg, Operations Analyst

SUBJECT: All Weather Flying Problems.

1. Operational experience of the 20th and of the 2nd Air Forces with B-29's has shown that precipitation static is one of the major problems in bad weather flying. According to our records a number of B-29's have been lost due to precipitation static and others have run into serious trouble. At least three cases are on record where B-29's had to be abandoned or ditched because of the fact that at crucial points during the flight, radio navigation aids were out of commission. One case happened last year off the coast of Africa where the pilot ran into very severe precipitation static, could not find his landing field and after flying up and down the coast for a considerable period of time ran out of gas and had to ditch. A second case happened in India where the pilot returning from the forward area ran into very severe static and was unable to contact his home field or any other field. The ceilings at that time were between 200 and 500 feet, the airplane became lost in unfamiliar territory and after running out of gas had to be abandoned. The third case occurred last summer with a B-29 returning from a long distance training flight in the Caribbean and being low on gas finally came to the vicinity of Oklahoma City; ceilings were approximately 800 feet, and the pilot requested the control tower to permit landing at the field. Due to precipitation static the radio contact with the field was extremely poor and the pilot understood the control tower operator that he could not land. After several other futile efforts to establish contact and unable to understand the control tower, the aircraft finally ran out of gas and had to be abandoned. In this connection it should be remembered that the B-29 accumulates electric charges at about 5.8 times the rate compared to the B-17 and hence is a great deal more affected by precipitation static. Recent experiences, even with the new type dischargers, have shown that the problem is far from solved and that considerable effort will have to be devoted to eliminate the trouble encountered.

2. Another problem that, in my opinion, requires attention at an early date is traffic control for long range bombers and fighters in the Pacific. Up to the present time operations have been on a relatively small scale. Only in one case did B-29's returning from the mission run into bad weather which required a cold recovery, however, due to the fact that take-offs were sufficiently widely spaced no critical problem arose at the time. The trend of operations

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Memo to Col. E. E. Aldrin
"All Weather Flying Problems"
27 March 1945

now indicates that much larger numbers of aircraft will be involved in future operations. The number of airfields and alternates available is distinctly limited, if any of them should ever be closed by bad weather then considerable number of aircraft might get into serious trouble. This is particularly true since operations continue to be carried out at the limit of the operational range of these aircraft and hence the available gasoline will be insufficient to permit long circling after returning. It is anticipated that this condition will not be too critical for the present B-29 based in the Pacific, because of the fact that these are essentially outside the bad weather belt and hence only occasionally affected by low ceiling and visibility conditions. It is, however; foreseen that more serious trouble will be encountered on the island bases that are contemplated for use of long range fighters. These are for a considerable period of time within the reach of bad weather fronts and hence it can be anticipated that serious bad weather flying problems will present themselves. Considering also the fact that gasoline reserves of these fighters are even more critical than in case of long range bombers, and also that these fighters do not carry navigators nor are they equipped with all the modern navigational aids that the bombers have, thought should be given to the bad weather landing problems at the earliest possible opportunity.

3. Another problem of bad weather flying that has affected B-29 operations to some extent, is severe turbulence. Not only is there evidence in the mission reports that the gasoline consumption goes up whenever these aircraft encounter severe turbulence enroute, there is also a case where severe turbulence has torn the bombs away from the shackles of an aircraft and driven them through the closed bomb bay door. In another case bombardiers have attributed poor bombing results to turbulence at high altitude. In addition it has been shown that the current automatic pilot installed in the B-29 is an unsatisfactory piece of equipment for cases of severe turbulence. Ultimately the missions as they are flown the present time are very fatiguing. Fifteen hours of flight in combat are a severe strain on every member of the crew and especially on the pilots. If this fatigue is increased by having to fly through heavy turbulence the possibility of accidents when landing is distinctly increased. It seems therefore, to be appropriate to devote a great deal more attention to this factor than has been done in the past.

4. These matters have had the attention of our Headquarters for a considerable length of time and I thought that you might like to have the information given above. Since I have not had, however, opportunity to clear this memorandum formally through our Headquarters, you will have to consider these points as personal information to enable you to formulate some of your problems rather than as an official statement on part of the 20th Air Force.

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Dr. H. E. Landsberg
Operations Analyst

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CRT/R.D.LANDSTROM/rmb/4039

17 Dec 1945

MEMORANDUM FOR MAJOR W. B. STAIN, OFFICE OF FLYING SAFETY, ROOM 4D-157

Subject: Bad Weather Flight Control.

1. An attempt was made to obtain an estimate on possible losses of aircraft in case poor weather conditions, requiring instrument approach, were prevalent at the bases on return.

2. The method used for arriving at these estimates is entirely indirect and based on numerous assumptions. The validity of the results is predicated on the assumptions. The problem was mainly to determine if a significant difference exists in losses that can be anticipated between:

a. the case that radio compass procedure envisaged by you is used or

b. the present conventional method of bringing aircraft in under low ceilings is employed.

3. The problem was approached by assuming that in all cases from which we have combat mission reports on file, aircraft would have had to be landed blind. In other words, a calculation was made what the losses might have been, had the weather closed in on the planes on their return to their bases. Altogether 26 reports from the XX Bomber Command and 17 reports from the XXI Bomber Command, which we have in our library, were used.

4. a. In each case it was determined how many airplanes had malfunctions of the radio compass system which were not required in flight. Presumably, these airplanes would have been in difficulty would they have had to use the approach system advocated by you. For simplicity, it was assumed that these airplanes would have been lost under the circumstances, although in reality some of these would, undoubtedly, have been able to use other means of instrument approach.

b. It was also determined what the average gasoline reserve of the returning airplanes had been on the missions under consideration. From this reserve the unusable portion was subtracted. According to Mr. Hooker, Boeing Flight Engineer, this would amount normally to about 250 gallons. The average consumption of gasoline during let-down for an airplane of gross weight of 90,000 lbs. (a reasonable assumption for returning aircraft) would have been 200 gallons perhour. It was then determined how many aircraft could

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have been brought in under a scheme requiring 4 minutes for landing each air lane. It was further assumed that 60 air lanes had to be landed per airdrome.

c. It is, of course, realized that the assumptions made under "b" above are quite pessimistic because it was not considered that some alternate fields might be open for visual landing.

d. The data thus obtained are presented in the attached table. This table gives in addition to mission number, number of [illegible] airborne aircraft, gas reserve on return, also the number and percentage of radio compass malfunctions, the number of aircraft that would have been lost on the 4-minute per plane procedure and how many additional airports would have been needed to bring them in safely with their reserve gas on return.

5. a. The results obtained from the tabulation is that 9.6 percent of the airborne aircraft might have been lost because of radio compass malfunctions.

b. The loss, in case 60 aircraft would have to be landed per field with the available gas reserve, one every four minutes, would have been 21.1% of the participating air lanes in case all fields closed in. Or, otherwise expressed, an average of two additional fields would have been needed to bring the aircraft in. In extreme cases, when gas reserve on return was particularly short, six or seven additional fields would have been needed.

c. It is also evident from the data that the risk of loss increases with the size of the force employed.

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XX BOMBER COMMAND

| Miss. No. | No. A/C | Malfunctions ARM-7 No. | % | Av. Gas Reserve gals. | Usable gals. | Hours | % A/C Short-of Gas | No. Add. Yields Needed |
|---|---|---|---|---|---|---|---|---|
| 3 | 28 | 1 | 3.6 | 880 | 640 | 2.36 | 0 | 0 |
| 4 | 111 | 0 | 0 | 1547 | 1336 | 4.96 | 0 | 0 |
| 5 | 59 | 0 | 0 | 1000 | 750 | 2.81 | 0 | 0 |
| 6 | 29 | 1 | 3.4 | 929 | 679 | 2.54 | 0 | 0 |
| 7 | 98 | 2 | 2.0 | 808 | 558 | 2.08 | 34.7 | 2 |
| 8 | 100 | 0 | 0 | 803 | 553 | 2.06 | 43.2 | 2 |
| 9 | 110 | 3 | 2.7 | 900 | 650 | 2.43 | 30.0 | 2 |
| 13 | 106 | 2 | 1.9 | 855 | 605 | 2.26 | 34.0 | 2 |
| 14 | 49 | 2 | 4.1 | 900 | 650 | 2.43 | 22.5 | 1 |
| 15 | 96 | 7 | 9.2 | 650 | 400 | 1.49 | 32.9 | 2 |
| 16 | 117 | 7 | 6.0 | 830 | 580 | 2.16 | 30.4 | 2 |
| 17 | 123 | 3 | 2.4 | 745 | 495 | 1.86 | 20.2 | 2 |
| 18 | 60 | 3 | 5.0 | 230 | 480 | 1.79 | 0 | 0 |
| 20 | 108 | 3 | 2.8 | 970 | 720 | 2.69 | 27.7 | 3 |
| 20 | 49 | 3 | 6.2 | 1068 | 818 | 3.06 | 0 | 0 |
| 21 | 64 | 2 | 3.1 | 1372 | 1122 | 4.20 | 0 | 0 |
| 22 | 36 | 2 | 5.6 | 952 | 702 | 2.64 | 0 | 0 |
| 23 | 49 | 4 | 8.2 | 1076 | 826 | 2.69 | 0 | 0 |
| 24 | 49 | 1 | 2.0 | 1185 | 935 | 3.50 | 0 | 0 |
| 25 | 49 | 4 | 8.2 | 461 | 201 | 0.75 | 69.5 | 4 |
| 26 | 46 | 2 | 4.4 | 753 | 503 | 1.88 | 34.8 | 1 |
| 27 | 47 | 1 | 2.1 | 608 | 428 | 0.50 | 47.0 | 1 |
| 28 | 40 | 1 | 2.5 | 755 | 505 | 1.90 | 30.4 | 1 |
| 29 | 92 | 4 | 4.3 | 943 | 693 | 2.59 | 10.9 | 1 |
| 32 | 25 | 0 | 0 | 770 | 520 | 1.95 | 0 | 0 |
| 33 | 113 | 3 | 2.7 | 578 | 438 | 1.40 | 54.8 | 3 |
| 34 | 67 | 5 | 7.5 | 641 | 391 | 1.46 | 25.9 | 2 |
| 35 | 64 | 2 | 3.1 | 1387 | 1137 | 4.26 | 0 | 0 |
| 36 | 59 | 0 | 0 | 1733 | 1483 | 5.56 | 0 | 1 |
| 37 | 58 | 1 | 1.7 | 824 | 574 | 2.14 | 44.1 | 1 |
| 38 | 116 | 1 | 0.9 | 651 | 401 | 1.50 | 60.4 | 6 |
| 41 | 64 | 0 | 0 | 708 | 458 | 1.72 | 18.8 | 1 |
| 42 | 49 | 1 | 2.1 | 702 | 452 | 1.69 | 47.0 | 1 |
| 43 | 29 | 0 | 0 | 776 | 526 | 1.96 | 0 | 0 |
| 44 | 27 | 0 | 0 | 1065 | 815 | 3.05 | 0 | 0 |
| 45 | 20 | 1 | 3.6 | 751 | 501 | 1.88 | 0 | 0 |

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XXI BOMBER COMMAND

| Miss. No | No. A/C | Malfunctions ARN-7 No. | % | Av. Gas Reserve Gals. | Usable Gals. | Hours | % A/C Short of Gas | No. Add. Fields Needed |
|---|---|---|---|---|---|---|---|---|
| 8 | 81 | 10 | 12.4 | 1093 | 843 | 3.16 | 0 | 0 |
| 9 | 29 | 3 | 10.4 | 1438 | 988 | 3.69 | 0 | 0 |
| 10 | 86 | 3 | 3.5 | 815 | 565 | 2.11 | 22.2 | 1 |
| 12 | 90 | 3 | 3.3 | 783 | 533 | 2.00 | 30.0 | 1 |
| 13 | 89 | 5 | 5.6 | 705 | 455 | 1.70 | 36.0 | 2 |
| 14 | 78 | 10 | 12.8 | 1046 | 796 | 2.98 | 0 | 0 |
| 15 | 29 | 0 | 0 | 1832 | 1582 | 5.86 | 0 | 0 |
| 29 | 118 | 7 | 5.9 | 538 | 288 | 1.08 | 76.2 | 7 |
| 34 | 117 | 5 | 4.3 | 1170 | 920 | 3.44 | 6.9 | 1 |
| 37 | 150 | 11 | 7.3 | 909 | 659 | 2.46 | 18.7 | 1 |
| 38 | 229 | 11 | 4.8 | 766 | 516 | 1.93 | 44.6 | 5 |
| 40 | 325 | 5 | 1.5 | 923 | 673 | 2.52 | 29.2 | 3 |
| 41 | 310 | 3 | 1.0 | 917 | 667 | 2.49 | 61.0 | 6 |
| 42 | 298 | 2 | 0.7 | 1062 | 812 | 3.04 | 55.6 | 4 |
| 43 | 331 | 3 | 0.9 | 812 | 562 | 2.11 | 41.4 | 5 |
| 44 | 310 | 2 | 0.6 | 1127 | 877 | 3.28 | 4.5 | 1 |
| 45 | 351 | 16 | 6.3 | 1038 | 788 | 2.94 | 45.9 | 3 |

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17 April 45

TO: COLONEL D. N. YATES, CHIEF, Weather Division

Subject: Preliminary Recommendations of Conference on "Far Eastern Weather".

1. The weather problems of the Twentieth Air Force are most intimately related to the subject of your Committee 1, i.e., cloud forecasts. It cannot be sufficiently stressed, how important and urgent that particular problem is.

2. It was noted that a good many of the proposals for research will need four, three to six months before any results can be expected. The importance of a fundamental approach to the problem is full well realized but it may well be that the estimates of the time required are too optimistic. In the meantime, the Twentieth Air Force will encounter its worst weather problems during the next four or five months.

3. It is, therefore, of the greatest importance that proposal 1 of Committee1, which is one of the few projects likely to give results, be put into effect as rapidly as possible. The proposed "cloud forecasting station" should have sufficient strength, preferably not dependent on present ASWCA weather personnel so that it can concentrate completely and solely on this job.

4. In the meantime, all important literature on cloud and cloud formation should be summarized and be made available to the forecasters in the theater. A selection of reports should immediately be made, so far as necessary translations obtained, and a pamphlet on this subject be sent out at once. Among the topics that should be considered for inclusion are excerpts from Byrd's book on clouds, studies by Lange and Berndl, and also the Japanese papers showing the distribution of clouds in various sectors of low pressure system.

5. The progress of Committee 1 are essentially directed toward the synoptic and dynamic approach to the cloud problem. It should be emphasized that all the work along this line will only be as successful as the primary observations. Cloud formation depends not only on vertical motion, etc., but also on the primary distribution of moisture in the atmosphere. Admittedly, the measurements

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of humidity aloft are most deficient at the present time. It is, therefore, recommended that equipment that can provide accurate measurements of humidity be immediately provided for the weather reconnaissance aircraft in the theater and for the fixed radiosonde stations. The new dew point recorder at the University of Chicago or equivalent equipment should be provided, even if only in a limited quantity as soon as feasible. In addition, aloft humidity indicators, such as the one constructed by Dr. Suomi, should be made available in quantity to forward area weather stations, as there on Iwo Jima and Okinawa.

6. Of the other proposals which can be put into effect immediately, recommendation 7 of Committee 3 and the recommendation of Committee 4 are endorsed and should be pushed to realization.

7. With respect to all other recommendations, it is urged that even partial solutions be made available to the field forecasters, even if only in form of informal progress reports because any improvements now in the forecasts, although they may only add little, weigh more heavily than complete solutions of the problems in a year.

HELMUT E. LANDSBERG
Operations Analyst

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19 March 1945

SUBJECT: Staff Weather Officer' Course at AAFSAT.

TO : Colonel D. N. Yates, Chief, Weather Division, OC & R.

THRU : DC/S, Training, Maintenance and Equipment, Twentieth Air Force.

1. Incidental to a recent visit to the Army Air Forces Board at Orlando, Florica, I had opportunity to acquaint myself with the organization of the Staff Weather Officers' Course at AAFSAT. It seemed desirable to determine how suitable this course would be for the training of staff weather officers for VLR Groups. On some previous visits to bases within the Second Air Force it has been noted that the lower-echelon staff weather officers were not as carefully selected as might have been desirable. In the light of this fact it seems worthwhile to exert a special effort to obtain some high caliber weather officers for VLR Groups.

2. The procedure at the school for staff weather officers has been reviewed to determine what subject matters would be useful for the training of VLR staff weather officers. The requirements for changes or additions to the course can be classed as follows:

a. Special selection of personnel for the course.

b. Changes in classroom curriculum.

c. Practical training in weather reconnaissance and tactical flying.

These items are dealt with in detail below.

3. a. It would probably be most advantageous to train staff weather officers for VLR Groups in units independent of the present staff weather officers' training program. The number of courses required has to be determined in the light of anticipated personnel needs. However, the size of each individual class should not exceed 20 men. The officers sent to the school should be carefully preselected. (The practice to dump "undesirables" into a school of this kind is to be deplored very much). No man should be chosen for the course who would not like to become a Staff Weather Officer. Each of the officers selected should have had about one (1) year of practical forecast experience in a weather station. Those with some overseas experience should be given preference. As the T/O for VHB Groups call for a captain as weather officer, the men sent the school should be first lieutenants. That will insure that these men have reached some level of experience and furthermore gives the Group commanders the opportunity to promote these men.

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b. Standards for VLR staff weather officers course should be very rigid and men not highly recommended should be disregarded for filling the jobs. In order to evaluate the personalities and check the qualifications of the ment from the point of view of the "consumer" an experienced operations officer should be a member of the faculty of the course for the period that staff weather officers for VLR Groups are being trained. An officer experienced in the weather problems in the Pacific Ocean Area should also be added to the teaching staff.

4. a. The length of the course will be determined by the necessary changes in curriculum but a lenfthening by at least two (2) or three (3) weeks, including the practical training outlined in paragraph 5 is indicated.

b. The following subjects could be eliminated from the curriculum without too much loss for VLR weather officers:

(1) Employment and capabilities of Medium Bombardment.

(2) Tactical Air Force Organization, Operations and Employment.

(3) Mission and Organization of Troop Carrier Aviation.

(4) Army Ground Forces Organization, Techniques and Tactics.

(5) European Theater Weather service and requirements.

(6) Africa and Middle East Theater Weather service and requirements

c. The following subjects should be added to the course:

(1) Employment and capabilities of VLR Bombardment.

(2) Employment and carabilities of VLR Fighters.

(3) Influence of weather on rest VLR operations.

(4) Weather service and requirements in POA and SWP theaters.

(5) Influence of weather on Air Chemical Operations.

(6) Problems of ballistic winds.

(7) Functions of Group Staff Weather Officers in weather training of air crew members.

(8) Functions of staff weather officer in accident investigations and analysis (especially of those accidents involving weather).

(9) Useful books and publications on weather to be included among Group equipment and as personal equipment for Staff Weather Officers.

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5. a. To make staff weather officers for VLR Groups fully effective They should receive training in the latest weather reconnaissance techniques. This type of training could be given at Orlando in cooperation between th school and the 26th Weather Region. The newest pieces of equipment are being tested the e and the Region has a fully equipped weather reconnaissance airplane available. Each of the weather officers selected for the VLR course should go on four (4) or five (5) weather reconnaissance flights. Experience thus gained will be of extra-ordinary value if weather reconnaissance has to be carried out by tactical units. The Staff Weather Officers will then be well prepared either to participate in such flights or properly instruct the crews who are to fly weather missions.

b. The staff weather officer trainee should also participate in about four (4) or five (5) tactical training flights. Prior to these flights he should brief the crew of his particular aircraft on weather and returning with them from the flight he should interrogate them on weather observations. In that fashion his abilities as briefing and interrogating officer can be assessed by the operations officer who is to be attached to the facalty of the staff weather officers' course. This procedure will make the training of a staff weather officer for an Air Force unit more realistic. It will also help to integrate eventually the weather officer into the staff team of his Group, most of whom are flying personnel. This flight training may have to be conducted at the conclusion of the course away from Orlando at the bases of a training Air Force.

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HEADQUARTERS, TWENTIETH AIR FORCE

OPERATIONS ANALYSIS DIVISION

WASHINGTON, D. C.

15 May 1945

# THE PROBLEM OF STAFF WEATHER OFFICER TRAINING FOR VLR AIR OPERATIONS

Report Prepared By:

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The purpose of the Very Long Range strategic Air Force is to reduce the enemy's war potential by effectively crippling his industry, his airpower, his transportation system and undermining his will to fight. Missions requiring round trips of 2500 to 3500 miles have become common place in the last year since employment of B-29s in the war against Japan. In all its aspects weather has a considerable, if not the decisive, influence upon fulfillment of the mission. This puts a tremendous responsibility on all weather personnel connected with Very Long Range operations, which soon will include Long Range Fighter operations also.

The burden of the forecasting task is now being carried in all theaters of operations by Weather Centrals where the best forecasters of the various weather regions have been gathered and where the scientific talent is concentrated. When this trend toward centralized forecasting began, about two years ago, many persons thought that the staff weather officer had been reduced to the role of a briefing officer who was just a parrot for the material sent to him by the weather central. This lead to a tendency to depreciate the staff weather officers, especially in the lower echelons. A further consequence was that the less qualified weather officers were put into the staff jobs and the better qualified personnel remained at the stations where forecasting was to be done.

This tendency, undeliberate as it may have been, has had some unfortunate consequences. It is the more a matter that deserves attention because of an additional factor that has worked to the detriment of the staff weather officer. In many cases, once he is assigned to a tactical unit, he is pigeon-holed and spends the remainder of his life in splendid isolation from the nourishing blood stream of information that keeps the personnel in the fixed weather service up-to-date. Unless he is a man of unusual initiative, who can dig up his own information through more or less private channels, he will soon become less and less useful to his organization. In fact, at times, he is in the unfortunate position of a salesman who is supposed to serve a consumer, but who doesn't really know what products his factory has available, what the merits of the product are and what new models can do for the consumer.

We have dwelt on this aspect for a while and some may think that the picture given is too black. Yet, it seems necessary to point to the problem in all its seriousness. There is no intention to blame anybody for this situation or to criticize a scheme which, in the difficulties offered by the tremendously rapid pace of the war, has perhaps been unavoidable. The sole purpose of these remarks is to help laying a foundation for the future.



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There is apt to be less pressure and a greater pool of personnel available on which to draw.

It seems apparent that part of the difficulties mentioned can be overcome by proper training.

It may be useful to bring out some of the requirements of operations and their relation to weather to enable one to set up standards for staff weather officers. What are the tasks which the staff weather officers have been confronted with?

Most common and most important is, of course, the job of briefing. This, in the higher echelons, means the briefing of the commanding generals or officers, in the lower echelons the briefing of the flight crews. Briefing is not just the reading to the assembled multitude of a forecast coming in over the teletype or obtained in the weather central or station. Briefing means to acquaint the personnel to be briefed with the important facts of the weather picture. Weather briefing is an art. It requires alertness on part of the briefer, the capability of adequately answering questions, - at times very embarrassing questions. It requires poise and good judgment. Questions should be answered with precision yet frankly and honestly. Some staff officers have acquired the bad habit of answering every question in some positive way, just because the question has been asked by an officer of higher rank. We have heard remarks to the effect, "If the General wants to know what the weather will be on the 15th of March 1945 at 1800 hours over Koiyo, we will give it to him". It is the job of the Staff Weather Officer to prevent the General from asking such a question. That requires tact.

Briefing techniques can to some extent be standardized, although in many cases special circumstances will require special handling. The standard techniques of briefing ought to be taught in a staff weather officer's course in all details, including all possible techniques of visual presentation. Good briefing requires a person who can talk freely, clearly and concisely, a person who can emphasize the proper things, who can be brief and yet complete. That requires personality.

In order to be a good staff weather officer one has to be thoroughly familiar with the capabilities of the air craft and crews involved. For VLR operations one would like to see that the staff weather officers know as much as possible about the particular aircraft. It would be highly desirable that they have made flights in them, that they know what a forecast, turned out on the ground, looks like in the air. Regarding capabilities of the crews they should know the difficulties



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that can readily be overcome by pilots and navigators, with years of experience in bad weather flying, are harassing and at times, unfortunately, killing experiences to men who have had only a limited amount of flying experience.

But the staff weather officer's job does not end with briefing. Interrogation of returning crews is of considerable importance. It is not only necessary to obtain weather information in that way for the forecasters in areas where every scrap of weather information is at a premium, it is also necessary to properly assess the effect of weather on missions. This last item is of importance for future planning, it is useful for the verification of forecasts and the assessment of difficulties encountered. Interrogation of crews returned from a combat mission requires a special technique, that can be taught, to overcome the understandable tendency on the part of tired personnel to "get it over with in a hurry". It needs good personal relations to the crews, and patience.

Very closely related to both briefing and interrogation are certain training functions that the staff weather officer has. It is in his hands to give the flying personnel certain lectures on weather during their unit training period. Times alloted for this are short and in many cases previous training in weather has evaporated from the minds of many of these men. Technical terms and theory are despised by flying crews. It is up to the staff weather officer to see to it that these men are not bored stiff but become interested in weather and that the information becomes part of their general knowledge. Teaching requires techniques that can be taught. The incipient staff weather officers ought to be instructed in those techniques.

In the case of VLR aircraft they will have to instruct the proper crew members also in the making of in-flight weather reports. This does not mean that they should just hand these men one of the AF codes and from then on hope the particular flight crew member will be "good" and conform to the instructions. The staff weather officer should go along on practice flights and supervise the making of observations. He should check all in-flight reports against other available information and point out discrepancies to the observer. He has to impress continuously upon the mind of the men in the flight crews that these reports are not just a confounded nuisance that are required by some superfluous regulation, but that they are an essential part of the weather information of the forecasters in many areas. And since the forecasts cannot be any better than the basic information, they become part of the life insurance of other flight crews who take off later.



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How sadly this phase of training was neglected was noted in the Pacific theater when the scantiness of weather information necessitated the use of ordinary tactical aircraft and crews, on a rotation basis, for weather recon aiss nce. For a while the vast majority of these reports was of little value because nobody had taken the pains to give appropriate instructions to the men flying these so-called weather strike missions. At times, the staff weather officers themselves had to fly weather reconnaissance missions. Hence, it is absolutely essential that they be familiar with all weather reconnaissance techniques and the use of the ordinary aircraft instruments such as thermometers, absolute and pressure altimeters, radar for weather reconnaissance purposes.

In all these phases of the staff weather officer's work, i.e., briefing, interrogation, weather reconnaissance, he acts as a liaison officer to the fixed weather service. His functions as such cannot be overemphasized. Allusion has already been made to the role of a salesman. He can do the fixed weather service a lot of good and on the other hand, can bring all his colleagues into disrepute. His responsibilities in that respect are considerable and while the proper remedy of difficulties encountered in this liaison function are not to be solved on the training but on the organizational level, it seems useful to point out that this problem exists.

While the foregoing essentially outlines the province of the lower echelon staff weather officer, the staff weather officer of the higher echelons have duties that can be made easier by proper training. They will be asked questions of an astonishing variety. They touch other scientific fields at times. They may include problems of daylight, twilight and moonlight. They often concern questions of climatology in all its aspects, including questions of "synoptic climatology" that are of great importance in operational planning. They may concern problems of oceanography, as they arise in connection with combined operations and air-sea rescue schemes. They confront him with questions about fire weather, precipitation static, ballistic winds, flight control, accidents involving weather, training schedules. (It may be stated parenthetically that these latter duties are not peculiar to Field Forces alone but arise as well in the domestic Air Forces, which, of course, are the habit-forming training grounds producing the personnel for the Combat Air Forces).

As can be gathered from the above enumeration, the subjects with which a staff weather officer will be confronted cover broad fields. Nobody expects the staff weather officer to be a living encyclopedia, but he has to be able to find the information desired and present it in a useful form, generally in writing. This



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necessitates two things; familiarity with available sources of information, such as reports and publications of the Weather Division Headquarters Army Air Forces, research results of the universities, intelligence material, etc., also the aptitude to reduce to writing for staff studies the pertinent information. This last task is by no means simple and many a good technical man is utterly inarticulate when it comes to conveying facts, known to him, to somebody else who, generally, is not technically trained in the same field. Appropriate training can help a great deal to force a man to "think clearly on paper".

This type of staff work also requires team work. The staff weather officer is one of the advisors of his commanding officer. Intelligent planning requires an integration of all available information into a coherent picture that will help the commanding officer to arrive at the best possible decision. For air operations, weather is one of the most important factors, hence all weather information in staff studies ought to carry considerable weight. It is the job of the staff weather officer to see to it that it receives the proper attention. He has therefore to be thoroughly familiar with the strategy and tactics of the weapons involved and with the details of the planned operations. This requires that he be fully acquainted with the phases of staff work covered by the other members of the staff team. He should have the cooperative spirit and the unselfishness that is a prerequisite for all team work.

The various postulates that have been set forth in the foregoing have to be translated into the training practice. Let us first summarize what is wanted. There are first certain character traits that seem desirable for a good staff weather officer. These are:

Interest in his job, initiative, alertness, good judgment, tact, patience, poise, cooperative spirit.

Next are certain aptitudes that should have been acquired in the previous training. These are:

Forecasting experience and work as station weather officer, ability to express himself in spoken and written word, good overall knowledge of climatology, atmospheric physics. Finally there are special phases of staff weather officer work which require thorough training. These are:

Briefing, capabilities of aircraft and weapon concerned, interrogation, training techniques to give crews weather training, familiarity with in-flight-reporting, knowledge of latest weather reconnaissance techniques, acquaintance with accident investigation



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procedure, knowledge of reports and publications of the Weather Service and meteorological research institutes.

It is obvious from this enumeration that one part of the job is to filter out through the training process those men who have the necessary character qualifications. This cannot be done by grading of examination papers, but is mainly the job of intelligent pre-selection of candidates for staff weather officer schooling by the men who are acquainted with their previous work. The responsibility of the persons charged with this selection is heavy and should not be shirked. Next is the personal interview with the officers selected, by a qualified personnel officer who can assess the character traits of the candidate. This should be followed by the theoretical course to which subjects not now taught at the Staff Weather Officer School ought to be added. (For VLR - operations this should include at least the following subjects: Employment and capabilities of VLR bombardment aircraft, employment and capabilities of VLR fighter aircraft, influence of weather on past VLR operations, weather service and requirements in the theaters of the war against Japan; influence of weather on air-chemical operations including incendiary attack; problems of ballistic winds; techniques of teaching weather subjects to air crew members; accident investigation; publications of the Weather Service). The final phase of training should be practical training in an operational unit, which would include actual briefing, interrogation and participation in reconnaissance and tactical training missions. Evaluation of the suitability of a candidate for staff work in this last phase should be made by experienced operations personnel rather than by technical weather personnel. The weeding process should go on continuously from the stages of pre-selection through personal interview to formal school course and final practice period.

It is inherent in those recommendations that the present course be considerably lengthened and strengthened. It is also emphasized again that the training of a staff weather officer should not end the moment he actually assumes such a job. He should be kept abreast of all technical developments in order to enable him to discharge his duties intelligently and to the best advantage of the organization he serves.



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WEAPONS - WEAPON SELECTION

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SAVE

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By Authority of
The Commanding General
Army Air Forces
22 Jan 45 RLS
Date Initials
FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

22 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH, AF

Subject: Weapon Analysis In the Twentieth Air Force

1. Summary. At this late date in the war there is an appalling lack of data on comparative effectiveness of HE and IB, and of the available IB. The information necessary to remedy this regrettable state of affairs is detailed herein together with the method of obtaining it. Specific recommendations are made in section 9.

2. Status Of Weapon Analysis In The USAAF. To determine the best weapon and fuzing, or combination of weapons, and to calculate the number of hits desired and from this the force required for future targets it is essential to have reliable data on weapon effectiveness and bombing accuracy. For a number of reasons much more attention has been focused on bombing accuracy than on weapon analysis and as a result quite satisfactory methods have been developed for accuracy studies while in weapon analysis the progress has been much more slow. After more than three years of war little reliable data on effectiveness of our bombs exists. Only recently has weapon analysis, particularly of mixed HE and IB attacks, received sufficient attention that the information required for reliable analysis has become evident. There is much room for improvement in both accuracy studies and weapon analyses in the Twentieth Air Force.

3. Information Required for Weapon Analysis. The dimensions (including heights and number of stories) and construction details (method of framing and material; steel, reinforced concrete, brick, timber, etc.) of the buildings and other structures and installations of the target are essential. The number of hits obtained on each structure with HE and with IB must be determined. Finally the damage must be assessed, carefully sorting out the damage as to its nature and the weapon causing it.

4. Structure of The Target. Reconnaissance photography is the chief source of the details of size and construction of the structures. Good clear photographs with a scale of 1:8,000 or 1:10,000 are necessary for this work. Most of the cover obtained to date has been closer to 1:15,000 and has seriously handicapped the interpreters. Cover should be flown several weeks before the attack to allow ample time for target analysis. Additional intelligence can be obtained from sources such as insurance records, ground reports, prisoner of war interrogations, etc. Post-attack cover often furnishes clearer detail on building structure.

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5. Locating The Bomb-fall. Post-attack cover, flown before the enemy has sufficient time to fill craters and clear debris, is invaluable in determining the number of hits, particularly of HE. But it is known that many hits are not seen in these photos due to gutted buildings, deep shadows and the like. Therefore a judicious use of post-attack cover and strike photographs furnishes the most reliable estimate of the number of HE hits. For IB, strike photographs are absolutely essential. It is extremely difficult to distinguish the crater of the M47 on post-attack cover; for the M50 it is impossible. However, if a series of strike-attack photos are taken by each formation carrying IB, it is comparatively easy to approximate the number of hits.

This series of photos should begin with "bombs-away" and should continue at short intervals (three to five seconds, the shorter the better) until the bombs hit. Ideally, sufficient exposures would be taken and at such intervals that it would be easy to follow the bombs down. Eighth Air Force uses a 6-second interval, the Fifteenth a 3-second interval. The camera must be tilted to follow the IB down as they trail behind the aircraft.

It is extremely important to define the patterns of HE and IB on the ground independently. Where the 500 GP and the M76 are dropped from the same ship it is impossible to photograph them down independently. This is relatively unimportant since they may reasonably be assumed to have a common pattern. But with other IB the ballistic differences make it generally advisable to carry them in separate formations, and necessary in any case to photograph them and the HE with different cameras.

6. Damage Assessment. For purposes of evaluating the weapon effectiveness it is necessary to determine the damage caused by each weapon. It is also important to distinguish between serious damage likely to interrupt production and minor damage which is unlikely to have such effect. Essential for this purpose are good cover and good interpreters. Clear photographs with a scale of approximately 1:8,000 are best and should be obtained immediately pre-attack and post-attack. Pre-attack cover flown a few weeks prior to the attack often forces the interpreter to guess what the target was like immediately pre-attack. More serious is a lapse of even a few days after the attack; it sometimes becomes difficult to determine the extent of the damage and impossible to tell what caused it.

Highly-trained interpreters with architectural or structural engineering background are required for this work. Damage is measured and classified as structural or superficial, and as fire, HE, and mixed. An Additional category is also used, serious damage to contents without structural damage. This is a most difficult one to distinguish.

7. Weapon Effectiveness. Once the structural analysis and the damage assessment have been completed the job of sorting out the damage among the types of buildings and the weapons used is begun. The most troublesome item to be dealt with is the mixed damage, fire damage occurring in buildings hit by HE. This is actually made up of pure HE damage, damage due to fires started by HE, and damage due to fires started by IB. The division must be made by one familiar with structures and weapons and armed with a knowledge of experience in past attacks. J.T.G. has experienced personnel trained



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for both the interpretation and the analytical work who are, in fact, making weapon analyses for the current targets. They are seriously handicapped at present due to (a) the small scale of the reconnaissance cover; (b) its lateness in some cases and lack in others (due to weather, etc.); (c) the lack of incompleteness of the strike-attack photographs.

In many attacks one or more formations failed to obtain adequate strike photos because of clouds, camera or personnel failure, etc. However in several attacks where the number of usable negatives obtained was reported in the mission reports, prints from only one quarter of them have been received at this Headquarters. (See Table I).

8. Influence Of The Weapons. A complicating factor in weapon analysis is the use of more than one weapon in attacking a target. It would not be very difficult to determine the effectiveness of a weapon if it alone were used, with a single fuzing, in a few attacks. But this has been done rarely, and should be done rarely, combined HE and IB being generally more effective than either alone. However there should be a very good reason for using more than one HE (or fuzing) and more than one IB in a single attack. For when this is done it makes a reliable weapon analysis almost impossible.

Generally speaking the present practice is to select the HE bomb and fuze and the IB that seem best suited for the target and use them in some combination. This is not beyond the capability of analysis, but where two HE's, two IB's, or two fuzings are used on the same target attempts at weapon analysis result only in confusion. Thus, in the present state of comparative ignorance of weapon effectiveness, especially the relative effectiveness of the available IB, it seems within the realm of reason to plan the attacks so that the damage and the weapon causing it may be indentified.

Table I. Strike Photographs Received at HQ. AAF, Washington
First 18 Missions of XX Bomber Command)

| No. | Date (1944) | Target | Day or Night | No. & Size of Formations | Strike Photographs Usable Negatives Obtained | Strike Photographs Number Prints Rec'd Here |
|---|---|---|---|---|---|---|
| 1 | ~~15/6~~ | Makasan Rwy Shops | D | No Information | Small No. (ng) | |
| 2 | 15/6 | Yawata | N | Single planes | | |
| 3 | 7/7 | Night Photo | N | Single planes | | |
| 4 | 29/7 | Anshan | D | 4-Ship form. planned | 220 | 136 |
| 5 | 10/8 | Pladjoe | N | Single planes | | 5 |
| 6 | 10/8 | Nagasaki | N | Single planes | | |
| 7 | 20/8 | Yawata | D | 4-Ship form. planned | 587 | 224 |
| | | | N | Single planes | | |
| 8 | 6/9 | Anshan | D | 27 (7 to 3) | 460 | 50 |
| 9 | 26/9 | Anshan | D | 10 (19 to 1) | Small No. (ng) | |
| 10 | 14/10 | Okayama | D | 14 (17 to 3) | No Information | 37 |
| 11 | 16/10 | Okayama | D | 4 (14 to 1) | No Information | 40 |
| | | Heito | D | 4 (10 to 3) | No Information | |
| 12 | 17/10 | Einansho | D | 2 (7 & 3) | No Information | 5 (9/10 Cloud |
| 13 | 25/10 | Omura | D | 7 (21 to 4) | No Information | 97 |
| 14 | 3/11 | Rwy Yds. Rangoon | D | 4 (13 to 9) | 302 | 85 |
| | 4/11 | Singapore | D | 17 singly & 9 (8 to 2) | 429 | 1/1 |
| 16 | 11/11 | Omura | D | 24 singly & 2 (3 & 2) | 279 | None of Omura |
| 17 | 21/11 | Omura | D | 2 singly & 8 (15 to 3) | 98 | |
| 18 | 27/11 | Rwy Yds, Bangkok | D | 3 singly & 4 (14 to 12) | 342 | 139 |



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9. Recommendations.

a. The Bomber Commands be directed:

1. To obtain strike-attack photographs for each formation as follows:

(a) One at the instant of "bombs-away."
(b) Additional ones at an interval not less than five seconds until the bombs strike the ground.
(c) Cameras be tilted to follow the bombs down.

2. That each set of photographs be fastened together and attached to a sheet showing a diagram of the formation and other essential information. A suggested form for such a sheet adequate for the needs of bombing accuracy and weapon analysis is appended to this paper. The photographic officer should keep a supply of these sheets on hand to facilitate his part of the job.

3. That each photograph be marked to give the essential data for this purpose. The marking now in use by the Twentieth Air Force is adequate, but it should be emphasized that each print should have the full legend. As a check list, the following data are needed: bombardment unit, mission number, aircraft number, print number, date, time, altitude, focal length, target name, latitude and longitude.

4. That prints of all strike-attack photographs for a mission, with sheets attached (see (2) above), be assembled and sent to Headquarters, Twentieth Air Force as soon as practicable after the missions.

5. That as nearly immediate pre-attack and post-attack cover with scale as nearly 1:8,000 as possible be obtained and prints forwarded to this Headquarters as soon as practicable.

6. That a weapon selection no more complicated than a single HE (and fuzing) and a single IB be used unless a very good reason exists for doing otherwise.

b. The complete set of prints be turned over to J.T.G. as soon as possible after their arrival at Headquarters.

c. The personnel at Bomber Command responsible for selection of weapons, obtaining and marking photographs, and for transmittal of the material to this Headquarters be thoroughly indoctrinated in the reasons for the request.

LEROY A. BROTHERS
Operations Analyst
Twentieth Air Force, CST

APPROVED:
ROBERT L. STEARNS, Chief
Operations Analysis Division, CST



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STRIKE PHOTO REPORT
AIR FORCE

1. SQUADRON _____ 2. GROUP _____ 3. WING _____ 4. COMMAND _____

5. DATE _____ 6. MISSION NO. _____ 7. TARGET _____

8. COORDINATES _____ 9. A/C NO. _____ 10. NEGATIVES PRINTED _____

11. INTERVAL BETWEEN PHOTOS _____ 12. HOW WAS CAMERA ACTIVATED? BY BOMB-SIGHT? _____ MANUALLY _____ 13. EXACT TIME OF BOMB RELEASE (GCT) _____

14. NO. OF BOMBS _____ 15. SIZE, TYPE, & DESIGNATION OF BOMBS _____

16. FUZING _____ 17. WAS CAMERA MOUNTED VERTICALLY? _____ 18, IF MOUNT TILTED, HOW MANY DEGREES? _____ 19. A/C TRACK AT MOMENT OF BOMB RELEASE _____

20. AREA PHOTOGRAPHED IF OTHER THAN TARGET _____ 21. TRUE GROUND SPEED _____ 22. TRUE ALTITUDE ABOVE TARGET _____ 23. TYPE OF CAMERA AND FOCAL LENGTH OF LENS. _____.

24. MODIFY SKETCH TO SHOW ACTUAL FORMATION & POSITION OF CAMERA A/C IN THE FORMATION AT BOMB RELEASE POINT:

PHOTOGRAPHER _____

PHOTO OFFICER _____

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27 February 1945

# WEAPON ANALYSIS

## Summary

Only by careful analysis of the target damage and by relating it to the weapons that caused it can we learn from our own experience. By so learning we can increase the effectiveness of our weapons and hence of future operations. The information needed for weapon analysis is detailed herein together with the means of obtaining it. A method of reporting is suggested.

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1. Status of Weapon Analysis in the USAAF. To determine the best weapon and fuzing, or combination of weapons, and to calculate the number of hits desired and from this the force required for future targets it is essential to have reliable data on weapon effectiveness and bombing accuracy. For a number of reasons much more attention has been focused on bombing accuracy than on weapon analysis and as a result quite satisfactory methods have been developed for accuracy studies while in weapon analysis the progress has been much more slow. After more than three years of war little reliable data on effectiveness of our bombs exists. Only recently has weapon analysis, particularly of mixed HE and IB attacks, received sufficient attention that the information required for reliable analysis has become evident.

2. Information Required for Weapon Analysis. The dimensions (including heights and number of stories) and construction details (method of framing and material; steel, reinforced concrete, brick, timber, etc.) of the buildings and other structures and installations of the target are essential. The number of hits obtained on each structure with HE and with IB must be determined. Finally the damage must be assessed, carefully sorting out the damage as to its nature and the weapon causing it.

3. Structure of the Target. Reconnaissance photography is the chief source of the details of size and construction of the structures. Good clear photographs with a scale of 1:8,000 or 1:10,000 are necessary for this work. Cover should be flown several weeks before the attack to allow ample time for target analysis. Additional intelligence can be obtained from sources such as insurance records, ground reports, prisoner of war interrogations, etc. Post-attack cover often furnishes clearer detail on building structure.

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4. Locating the Bomb-fall. Post-attack cover, flown before the enemy has sufficient time to fill craters and clear debris, is invaluable in determining the number of hits, particularly of HE. But it is known that many hits are not seen in these photos due to gutted buildings, deep shadows and the like. Therefore a judicious use of post-attack cover and strike photographs furnishes the only reliable estimate of the number of HE hits. For IB, strike photographs are absolutely essential. It is extremely difficult to distinguish the crater of the M47 on post-attack cover; for the M50 it is impossible. However, if a series of strike-attack photos are taken by each formation, it is comparatively easy to approximate the number of hits.

This series of photos should begin with "bombs-away" and should continue at short intervals (three to five seconds, the shorter the better) until the bombs hit. Ideally, sufficient exposures would be taken and at such intervals that it would be easy to follow the bombs down. Eighth Air Force uses a 6-second interval, the Fifteenth a 3-second interval. The camera must be tilted to follow the IB down as they trail behind the aircraft.

It is extremely important to define the patterns of HE and IB on the ground independently. Where the 500 GP and the M76 are dropped from the same ship it is impossible to photograph them down independently. This is relatively unimportant since they may reasonably be assumed to have a common pattern. But with other IB the ballistic differences make it frequently advisable to carry them in separate formations, and necessary in any case to photograph them and the HE with different cameras. As insurance only it would be wise to carry several cameras in each formation.

In addition, a careful photogrammetric analysis of the photos obtained by a number of aircraft in a single formation might shed light on a number of the hitherto unanswered questions regarding bombing such as: actual shape and dimensions of the formation during the bomb run, the actual headings of the various airplanes in the formation at bombs-away, did the lead bombardier actually identify the aiming point?, etc.

5. Damage Assessment. For purposes of evaluating the weapon effectiveness it is necessary to determine the damage caused by each weapon. It is also important to distinguish between serious damage likely to interrupt production and minor damage which is unlikely to have such effect. Essential for this purpose are good cover and good interpreters. Clear photographs with a scale of approximately 1:8,000 are best and should be obtained immediately pre-attack and post-attack. Pre-attack cover flown a few weeks prior to the attack, while useful for the original target analysis and force requirements study, may not show the target as it was at the time it was attacked, thus forcing the interpreter to guess what its condition was immediately pre-attack. This is especially aggravating when post-attack cover for an earlier attack has to be used as pre-attack cover



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for the next attack. More serious is a lapse of even a few days after the attack in obtaining post-attack cover; the enemy is almost certain to fill craters and make some clearance, perhaps make some repairs. It sometimes becomes difficult to determine the extent of the damage and impossible to tell what caused it.

Highly-trained interpreters with architectural or structural engineering background are required for this work. Damage is measured and classified as structural or superficial, and as fire, HE, and mixed. An additional category is also used, serious damage to contents without structural damage. This is a most difficult one to distinguish.

6. Weapon Effectiveness. Once the structural analysis, the bomb-plot and the damage assessment have been completed the job of sorting out the damage among the types of buildings and the weapons causing it is begun. The most troublesome item to be dealt with is the mixed damage, fire damage occurring in buildings hit by HE. This is actually made up of pure HE damage, damage due to fires started by HE, and damage due to fires started by IB. The division must be made by one familiar with structures and weapons and armed with a knowledge of experience in past attacks. The Joint Target Group at Headquarters USAAF has experienced personnel trained in both the interpretation and analysis work who are, in fact, making weapon analyses for the current targets of the Twentieth Air Force.

7. Influence of the Weapons. A complicating factor in weapon analysis is the use of more than one weapon in attacking a target. It would not be very difficult to determine the effectiveness of a weapon if it alone were used, with a single fuzing, in a few attacks. But this has been done rarely, and should be done rarely, combined HE and IB being generally more effective than either alone. However, except where dictated by sound operational reasons, more than one HE (or fuzing) and more than one IB should not be used in a single attack. For when this is done it makes a reliable weapon analysis almost impossible.

Generally speaking the present practice is to select the HE bomb and fuze and the IB that seem best suited for the target and use them in some combination. This is not beyond the capability of analysis, but where two HE's, two IB's, or two fuzings are used on the same target attempts at weapon analysis result only in confusion. Thus, in the present state of comparative ignorance of weapon effectiveness, especially the relative effectiveness of the available IB, it seems within the realm of reason to plan the attacks so that the damage and the weapon causing it may be identified.

This does not mean that varied weapon selections should be avoided. On the contrary, a carefully planned and controlled program



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of weapon selection can easily furnish the answers to a number of rather pressing questions, such as:

a. Which IB is best for a particular target?

b. What fuzing is best for a particular type of structure?

c. What combination of HE and IB is best for a particular type of target?

8. Summary of Photography Necessary. It is essential that reconnaissance photography as nearly ideal as practicable be obtained and sent as rapidly as possible to the unit responsible for weapon analysis. All photography existing should be made available but immediate pre and post-attack are most useful, preferably clear and approximately 1:8000 (or larger) in scale.

It is also essential that the best possible strike photography be furnished as promptly as possible. Cameras with at least 24-inch focal length are best, the first exposure should coincide with bombs-away (camera should be activated by the bomb-release switch), and photography should continue until the bombs strike. The camera should be oriented so that the long dimension of the film is parallel to the track of the airplane, the intervalometer of the camera should be not greater than 5 seconds (preferably 3 seconds), and the camera mount should be tilted to follow the bombs as they trail behind the plane when trail is excessive (IB clusters, etc.).

Each photo must bear a legend identifying it with the aircraft (by the last three or four digits of its serial number) and the bomb group, as well as the usual data: focal length of camera, time, altitude, etc. The most important of these is the altitude which should be given as accurately and exactly as possible, this being the only means of obtaining the scale of the photo in many cases.

All photographs taken during the attack should be sent to the weapons analyst, regardless of how much cloud cover they show. If any ground detail is visible it may help in reconstructing the actual attack. Any photos showing the bombs in the air are extremely helpful; they are indispensable in the cases where the actual bomb-strike is not photographed.

9. Suggested Method of Reporting. It is fortunate that the information required for weapon analysis is largely the same as that required for bombing accuracy analysis. The following form of reporting eliminates repetition insofar as possible, assuming more than one formation attacks the target and more than one camera per formation:

a. For entire mission

1. Mission number
2. Date
3. Target no. and name of primary target (P.T)



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4. Number, type and fuzing of bombs dropped over P.T.
   (a) HE
   (b) IB
5. Bomb plot (if one is made in the theater)
   (a) Should distinguish between HE and IB if possible
   (b) Should state:
      (1) No. bombs dropped
      (2) No. bombs identified (whether HE only, HE and IB independently, or HE and IB together)
      (3) Percent within 1000, 2000 and 3000 feet of A.P.
6. No. of formations over P.T.

b. For each formation over P.T.

1. Mission no. (or date)
2. Numerical order of formation over target (i.e., 1st, 2nd, 3rd, etc.)
3. Diagram of formation identifying each A/C by the last three or four numbers of its serial number; and by the bomb group to which it belongs.
4. No. of A/C in formation
5. No. of A/C releasing over P.T.
6. Total bomb load - type of bombs
7. Bombs dropped on P.T. - type of bombs
8. Time of release
9. Method of release (visual, radar)
10. True altitude above target
11. Heading (degrees)*
12. True air speed *
13. Ground speed *
14. Intervalometer setting for bombs
15. Dropping angle *
16. Drift angle*
17. Serial numbers of A/C taking photos

c. For each series of strike photos

1. Mission number (or date)
2. A/C number and group number of plane taking photos
3. Type of camera
4. Focal length
5. Total negatives exposed
6. Interval between photos
7. Number of prints forwarded
8. How was camera activated? By bombsight? Manually?

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9. Was camera mounted vertically? If not, degrees of tilt
10. Area photographed if other than P.T.

*Ballistic data will help in estimation of bomb-fall where photos do not show actual strike. It will also be useful in studying such problems as causes of gross errors, aiming point identification, the actual formation on the bomb run, etc.

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APPROVED:

ROBERT L. STEARNS, Chief,
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LEROY A. BROTHERS
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Twentieth Air Force



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SAVE

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By Authority of
The Commanding General
Army Air Forces
8 Jan 45 RLS
Date Initials

TOP VICTORY
BUY UNITED STATES WAR BONDS AND STAMPS

8 January 1945

MEMORANDUM FOR THE CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: Critique of Weapon Selection for the First Eighteen Missions of the XX Bomber Command

1. At the request of the Deputy Chief of Staff, Combat Operations and Related Activities, the selection of weapons for the first eighteen missions of the XX Bomber Command has been examined, appraised and compared with the recommendations of the Joint Target Group and the publication of the Army Air Forces Board, "Selection of Bombs and Fuses for Bombardment Targets", dated 18 October 1944. Table I shows the comparison, the last column giving my recommendation. Each mission is discussed briefly in a following paragraph.

2. It is realized that the bomb and fuze suggested herein for several of the missions were not available in the theatre at the dates of the missions. It should also be noted that the Joint Target Group has only recently begun to issue its Target Information Sheets, that they were not available to XX Bomber Command for any of these missions, and that Joint Target Group is still not prepared to make recommendations for some of the targets. Finally it must be realized that a specific recommendation regarding the proportioning of HE and IB in the total load requires a laborious and highly technical study of the target. However, for aircraft and aero-engine plants, the damage resulting does not seem extremely sensitive to changes in this proportion through a relatively wide range in the vicinity of one-half. Therefore, in certain cases it has seemed reasonable to suggest a 50-50 distribution of HE and IB, in the absence of a complete study.

3. Summary of Principal Differences: The principal difference appearing in Table I (Page 5) may be summarized briefly, as follows:

a. The Army Air Forces Board rarely agrees with the selection of the XX Bomber Command, with that of Joint Target Group, or my own.

b. XX Bomber Command, Joint Target Group and I are in general agreement in the selection of HE weapon and in recommending mixed HE and IB loads for targets.

c. Joint Target Group, Army Air Forces Board and I generally recommend the smaller IB (M50) for the targets where XX Bomber Command has used the 500# M76.

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d. Joint Target Group and I agree that the nose fuze and tail fuze should be set for the same delay. This will increase the number of explosions at the desired level in the building where the roofing is not sufficiently heavy to activate the tail fuze.

e. Joint Target Group, Army Air Forces Board and I agree on an oil incendiary for an oil refinery, while at Palembang the XX Bomber Command used a magnesium bomb; all agree on a very small proportion of IB.

f. I suggest the M83 (Butterfly) frag for use with the M69 on urban-area attacks, Army Air Forces Board the 100 GP, XX Bomber Command the 20# frag (M41), and Joint Target Group 100% IB.

4. Mission No. 1, Makasan Railway Shops: This target consisted principally of light, steel-framed, single-story sheds though there were one or two sturdier buildings housing heavy equipment and having large fire divisions. The car repair shop, wheel shop, carpenter shop and carpenter stores invited incendiary attack. Thus the higher proportion of IB is suggested. The M50 is chosen in preference to the M69 for its greater penetrative ability.

5. Mission No. 2, Imperial Iron and Steel Works: (Coke Ovens) The 2000# GP fuzed 1/40 tail and nose would be preferred here if the bombing could have been visual and the pay load per ship had not been so small. Coke batteries are difficult to destroy and more difficult to hit. Therefore the big bomb is chosen both for its direct-hit and near-miss advantage over the smaller one. However, preferring some damage rather than none, and hoping for the secondary explosions that sometimes have resulted, the 500 GP was a good choice.

6. Mission No. 3, Sasebo Naval Dockyards: Since this attack could cause little damage (14-ship night attack on several targets), falling more or less in the "nuisance" class, the weapon choice is relatively unimportant. The bomb used was all right but 50% M17 clusters (or perhaps 100%) would probably result in more damage in the surrounding areas and perhaps as much in the target areas.

7. Mission No. 4, Showa Steel Works: (Coke Ovens) Again, the 500 GP is agreed upon as a good compromise weapon. However, if the ships could have carried double their payload, the 2000 GP would be preferred for the reasons stated in discussing Mission No. 2. Further, much more damage would result in the steel mill proper from the overspill using this bomb.

8. Mission No. 5, Pladjoe Refinery: Most of the installations at Pladjoe, while relatively immune to damage from near-misses, would suffer serious damage from direct-hits with 250# GP. This bomb with the 1/40 fuzing would open up the tanks and burst the pipes both in the pump houses and underground. Experience has shown that HE alone causes many fires where pipes and tanks carry light oils or gasoline.

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However, it is recommended that some of the later formations should drop a few IB to make certain to ignite the escaping oil. The M69 is preferred since clearly the best way to ignite oil is with burning oil. Further it is feared that the M50 may bury itself in the ground or simply "go out" if it hits in a tank or a deep pool. The M69 will not penetrate as deeply in earth and its ejection feature will assure it a much greater chance of effectiveness.

9. Mission No. 6, Urban-area, Nagasaki: The proportion of frags used in this attack was a little on the high side, in fact a fair argument can be made for 100% IB if the frag must be the 20# with instantaneous fuze. The ballistics of this bomb differ so greatly from those of the M69 that overlappings of patterns is by no means assured and, further, the instantaneous fuzing results in extremely brief effectiveness for the frags. The M83 (Butterfly) with mixed delay and anti-disturbance fuzing or a rather high proportion of X-bombs would be preferred. Since neither was available for this attack, 100% M69 should have been used. The Army Air Forces Board recommends the M74 when they are available and the M69 until that time. Their recommendation of the 100# GP is perhaps a misprint.

10. Missions 7, 8 and 9 (Coke Ovens): See above.

11. Mission No. 10, Okayama Aircraft Factory: The target structure was principally light steel-framed sheds and hangars. The presence of a number of long-span hangars with the possibility of spreading collapse weighted Joint Target Group's choice in favor of the 2000# GP. This is not a bad choice and certainly precludes the selection of the 250 GP as suggested by Army Air Forces Board. The 500 and 1000 GPs compute to be practically equally effective and slightly less so than the 2000. With the choice so close, I prefer the 500 fuzed 1/100 nose and tail, though it is probable that the M139 nose fuze was not available for this attack. As soon as it is available, it should be used for this type of building since it appears that somewhat less than half the tail fuzes are activated by the roofs. The M76 IB appears to have put on a good show against this target but the theory predicts that a smaller bomb would have done the job much more efficiently. It is unfortunately true that with all the bombing in the European Theatre as yet no satisfactory method of evaluating the effectiveness of IB has been developed.

12. Missions 11 and 12: See Mission 10.

13. Mission No. 13, Omura Aircraft Assembly Plant: The principal criticism of the weapons used in this attack is the use of two IB. Where more than one HE, more than one fuzing, or more than one IB are used in the same attack it becomes impossible to determine the effects of the weapons. At the present stage of uncertainty of relative effectiveness of the available IB no opportunity should be wasted to measure the effectiveness of a weapon under combat conditions. Thus a single HE (and fuzing) and a single IB should be used in each attack unless there is some good reason to do otherwise. If this practice is followed, the bombfall (both HE and IB) is accurately located by strike photographs, and good large-scale post-attack



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cover is obtained the effectiveness of a weapon or a combination of weapons can be determined. It is interesting that the reasons given in the Mission Report for using 25% M50s are sound and might well have been used to support a recommendation of 50% M50 and no M76. Both Joint Target Group and the Army Air Forces Board recommend the M50, and I agree. The Army Air Forces Board suggests the 250 GP or perhaps the 100 GP, but stand alone in this recommendation. They also stand alone in their recommendation of the 1/40 fuze.

14. Mission No. 14, Malagon R. R. Yards: The weapon and fuze used were good. Again the Army Air Forces Board is in partial disagreement in recommending the 100 GP fuzed 0.1/ND and in fuzing the 500 GP 0.1/o.ol.

15. Mission No. 15, Singapore Naval Base: The Mission Report states that the 1000 GP was preferred for this target but a 500 GP was added where possible to assure the maximum possible load. The best bomb for this target is the 2000 GP and neither the 1000 nor the 500 is likely to prove particularly effective. However, due to the long haul and necessarily light load the 2000 would have been a poor choice. Therefore the 500 GP and the 500# M76 are recommended. The 1/10 fuzing of the HE will allow it ample time to pass through the rather high-roofed buildings and penetrate sufficiently to cause optimum craters.

16. Missions No. 16 and 17, Omura Aircraft Plant: See Mission No. 13.

17. Mission No. 18, Bansue Marshalling Yards: See Mission No. 14.

L. A. BROTHERS,
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief
Operations Analysis Division
Twentieth Air Force







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Table I. Critique of Weapon Selection for 1st 18 Missions of XX Bomber Command

| Mission No. | Target | Day or Night | 500 Weapons Used | | RECOMMENDATIONS J. T. G. x | A A F Board ≠ | L. A. B. ⊕ | |
|---|---|---|---|---|---|---|---|---|
| 1 | Makasan Rwy Shops Bangkok | D | GP o.1/0.025<br>M18 (M69) | 75%<br>25% | | 500 GP o.1/0.025 | 500 GP 0.01/0.01<br>M17 (M50) | 50%<br>50% |
| 2 | Imperial Iron & Steel Works, Yawata (Coke ovens) | N | 500 GP 0.1/0.025 | | 500 GP 0.1/0.1 | 250 GP 0.1/0.025 | 500 GP o.025/0.025* | |
| 3 | Sasebo Naval Dockyards Kyushu | N | 500 GP 0.1/0.025 | | | 500 GP 0.1/0.025 and 100 GP 0.1/0.025 | 500 GP 0.025/0.025<br>M17 (M50) | 50%<br>50% |
| 4 | Showa Steel Works Anshan (Coke ovens) | D | 500 GP 0.1/0.025 | | Same as 2 | Same as 2 | Same as 2 | |
| 5 | Pladjoe Refinery Palembang | N | 500 GP 0.1/0.025<br>M17<br>MK26 Mines | 65%<br>9%<br>26% | 500 GP 0.1/0.01<br>10% M69 (in last formation) | 100 GP 0.1/0.025/95%<br>M74 5% | 250 GP 0.025/0.025<br>M18 (M69)<br>MK26 Mines | 70%<br>5%<br>25% |
| 6 | Urban-area Nagasaki | N | M18 (M69)<br>M26 (M41) | 76%<br>24% | M69 | 100 GP 0.1/0.025<br>500 M74A airburst | M18 (M69)<br>M29 (M83 Butterfly) | 80%<br>20% |
| 7 | Yawata<br>Same as 2 | D<br>N | Same as 2 | | Same as 2 | Same as 2 | Same as 2 | |
| 8 | Anshan<br>Same as 4 | D | Same as 2 | | Same as 2 | Same as 2 | Same as 2 | |
| 9 | Anshan<br>Same as 4 | D | Same as 2 | | Same as 2 | Same as 2 | Same as 2 | |
| 10 | Okayama A/C Factory Formosa | D | 500 GP 0.1/0.01<br>500 M76 Inst/ND | 60%<br>40% | 2000 GP 0.01/0.01<br>M17 (M50) | 250 GP 0.1/0.025<br>M17 (M50) | 500 GP 0.01/0.01<br>M17 (M50) | 50%<br>50% |
| 11 | Okayama, same as 10<br>Heito Airport | D<br>D | " but<br>" but | 62%-38%<br>67%-33% | " | " | " | |
| 12 | Kinanshe A/C Depot Formosa | D | " but | 71%-29% | | " | " | |
| 13 | Omura A/C Plant Kyushu | D | 500 GP 0.1/0.01<br>M17 (M50)<br>M76 Inst/ND | 50%<br>25%<br>25% | 500 GP 0.01/0.01<br>M17 (M50) | " | " | |
| 14 | Malagon R. R. Yards Rangoon | D | 500 GP 0.1/0.025 | | | 100 GP o.1/ND<br>500 GP o.1/0.01 | 500 GP 0.025/0.025 | |
| 15 | Singapore Naval Base Singapore | D | 1000 GP o.1/0.025 and 500 GP o.1/0.025 | | | Same as 3 | 500 GP 0.1/0.1*<br>M76 Inst/ND | 60%<br>40% |
| 16 | Omura<br>Same as 13 | D | 500 GP 0.1/0.01<br>M76 Inst/ND | 66%<br>34% | Same as 13 | Same as 10 | Same as 10 | |
| 17 | Omura<br>Same as 13 | D | " | | " | " | " | |
| 18 | Bansue Marshalling Yds. Bangkok | D | Same as 14 | | | Same as 14 | Same as 14 | |

(See Page 6 for footnotes)



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FOOTNOTES FOR TABLE I.

x Joint Target Group not prepared to make more complete recommendations without making elaborate target studies.

≠ An effort has been made to reconcile the targets and the categories listed in the Army Air Forces Board report, "Selection of Bombs and Fuzes for Bombardment Targets". This, therefore, is my interpretation of the Army Air Forces Board selections for these targets.

⊙ Recommendation of L. A. Brothers, the writer of this paper.

* 2000# GP preferred but 500 GP recommended because of limited load that could be carried.

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26 March 1945

MEMORANDUM FOR CHIEF OF STAFF, TWENTIETH AIR FORCE

Subject: Comments on Attached Memorandum, "Controlled Bombing Attacks on Japanese Targets".


Summary

The memorandum is the product of the top men in both the HE and IB divisions of NDRC*. The "controlled" bombing program suggested is well-conceived. If successfully carried out it will answer the most urgent of the many vexing questions regarding weapon effectiveness. With minor modifications it can be carried out with a minimum of disturbance of present plans. It is the recommendation of the Operations Analysis Division that the suggested program be adopted insofar as is operationally feasible.


1. The attached memorandum, "Controlled Bombing Attacks on Japanese Targets", was submitted to the Operations Analysis Division for transmittal to the Twentieth Air Force after an informal three-cornered agreement between the DC/S, Combat Operations, Twentieth Air Force; Division 2 and Section 11.3 of NDRC*; and the Operations Analysis Division. It is the result of careful deliberation on the part of men eminently qualified to speak on the present shortcomings in the data on weapon effectiveness, the top men of the branches of NDRC most closely concerned with the effectiveness of both HE and IB.

*The following men are responsible for the attached memorandum: National Defense Research Committee (of the Office of Scientific Research and Development), Division 2 (Effects of Impact and Explosion, HE Bombs) Dr. E. Bright Wilson, Jr., Chief, Professor Walker Bleakney, Dr. A.H. Taub and Mr. R. J. Slutz, Section 11.3 of Division 11 (Incendiary Bombs) Prof. H. C. Hottel, Chief, Dr. R. H. Ewell and Dr. C. S. Keevil, AN-23 Project (Joint HE-IB Group from Divisions 2 and 11) Dr. V. Rojansky, Dr. H. F. Bohnenblust, Mr. Robert J. Hanson, Mr. E. B. Gerry and Dr. G. W. King. Also present at the discussions were Dr. Nathan M. Newmark of the AAF Scientific Advisory Group, Dr. Merrit P. White, Scientific Adviser to the Physical Vulnerability Section of the Joint Target Group, and Mr. LeRoy A. Brothers of the Operations Analysis Division, Twentieth Air Force.

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These men have been studying effects of bombs since the days when NDRC was principally concerned with defense; they are fully acquainted with the effects of German bombs on British construction with the effects of British and American bombs on German targets, with the somewhat limited data on effects of our bombs on Japanese targets; and are in constant touch with the increasingly revealing results of the US Strategic Bombing Survey of targets in the rapidly expanding reconquered territory in ETO.

2. The memorandum paints an accurate picture of the present status of our knowledge of the effectiveness of our bombs. It lists the questions as yet unanswered and proposes a program of "controlled" bombing attacks designed to obtain the answers most urgently needed now. It lists the data required for proper analysis of a controlled attack. The authors have made a sincere effort to keep within operationally feasible bounds while suggesting the minimum of special conditions necessary for the success of the project. On the whole they have done a good job; the paper will be discussed in detail in the following paragraphs.

3. In Section III of the memorandum the term, "controlled attack" is defined. It is also pointed out that most attacks can be controlled attacks, in that the weapons used and the data obtained can be such that it will be possible to evaluate weapon effectiveness following the attack. Actually, the weapons used in most Twentieth Air Force attacks to date have been perfectly susceptible of analysis, the weakness has thus far been in the data obtained. This weakness is realized however and the recent Twentieth Air Force directive on mission reporting profides for obtaining and reporting data necessary for weapon analysis.

Thus in day-to-day attacks when operational conditions permit much valuable data will be obtained. The Joint Target Group routinely makes a weapon analysis when the data are sufficient. However, since it will be perfectly possible to plan a few controlled attacks to fill specific blanks in the present knowledge of effectiveness of our weapons without sacrificing expected damage to the target and without upsetting routine operational procedures appreciably there seems to be no reason not to do so.

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4. The written data required, as detailed in Section IV of the memorandum, are much the same as have recently been made SOP in the Twentieth Air Force. They differ from SOP in minor detail only; the standard reporting is entirely adequate.

By "sufficiently long shadows" in pre-attack cover is meant shadow lengths equal to or greater than the actual heights of buildings. Longer shadows more clearly define shape of structure and are more accurately measured. The hours during which this condition will exist vary with latitude and season of the year but for the Japanese home islands it is sufficient to say that the period from 10:30 to 14:00 (local sun time at the target) should be avoided as much as possible in obtaining pre-attack cover.

By "sufficiently short shadows" in post-attack cover is meant as short as possible; high noon (local sun time at the target) is ideal. Shadows conceal craters often and damage to low installations adjacent to higher ones sometimes.

Cover flown an hour or so after the attack (in addition to post-attack cover the following day) may seem unreasonable but will prove so extremely useful, particularly in incendiary attacks, that it should more than pay its way.

The three-second interval between strike photos is also highly desirable; a longer interval allows HE bursts to "flower" and merge, and misses many IB flashes (3 seconds is just about the visible life of the M47 flash).

Automatic time records on the photos are desirable but the present cameras are not equipped to make them. Since the camera mount is not in the pressurized part of the airplane it will require a modification to make it possible to "focus" the camera when approaching the target. However, this is another very desirable thing and would undoubtedly result in improvement in the average quality of photography. Conditions of light, altitude, etc. are not always actually "as briefed."

5. The program recommended in Section V was presented as a starting or minimum program selected to shed light on the more urgent of the presently obscure questions. Effectiveness of the 4000 L C is unknown and especially urgent now that "bigger and better" bombs are being built. The encouraging performance of the M69 on industrial plants in the Kobe attack of 4 February 1945 makes the need for accurate data on this weapon rather urgent; it or the M74 may supplant the M50 for industrial targets and thus become an all-purpose bomb (for industrial or urban targets, thus simplifying the problem of selection of weapon for both primary and secondary targets). The data on

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effectiveness of mixed HE-IB loads is very spotty. The 500 GP is the weapon best known today but in order to maintain control in a program such as this a few attacks using the weapon to which basic comparisons will be made are essential. The 0.01/0.01 fusing is an attempt to assure detonation among the supporting structural members of the roof. This fusing has been recommended for this type of structure; more recently JTG has recommended 0.01 nose, non-delay tail.

The number of attacks suggested was arrived at by a statistical calculation to determine the minimum number from which it is probable that results will be obtained with reasonable assurance.

It should not be difficult to select the necessary 20 targets as specified. AN-23 would gladly cooperate with JTG in suggesting suitable targets and in analyzing the results. The density of one ten per acre suggested for these targets was chosen to assure the desired level of damage.

The delivery capacity of the Twentieth Air Force from present bases is insufficient to achieve such a density on four targets (assuming 100 acres for an average target) simultaneously. However such a condition is desirable and should be approached as a goal.

6. In the appendix of the memorandum are listed a numberof additional controlled attacks designed to answer other questions not considered quite so urgent as those to be answered by the program recommended in Section V. of these the one most urgent, and very nearly as important as any, is listed as 1.ii. "Medium bombs: 500 GP, fused 0.01 tail, long-delay nose". By "long-delay" is meant several hours, sufficiently long to allow post-attack cover to be obtained an hour or so after the attack and before the nose fuzes act. This would allow an accurate determination of the percentages of tail fuzes activated by the roofs, functioning at floor level, and failing to function; also the damage resulting from each. Heretofore, it has not been possible to distinquish between the craters caused by the tail detonation and those caused by the 0.1 nose fuze; estimates of the percent of tail fuzes activated by the roofs have varied widely.

7. Conclusions and Recommendations. The program of controlled attacks proposed in the attached memorandum is well-conceived. It will provide data on weapon effectiveness urgently needed now. It will not interfere with present operational procedures appreciably. Therefore,

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it is recommended that the program as set forth in Section V of the memorandum be adopted insofar as is operationally feasible. It is further recommended that the AN-23 project group supervised by Dr. V. Rojansky, be invited to collaborate with JTG in suggesting suitable targets and in analyzing the results of the attacks.

LEROY A. BROTHERS
Operations Analyst
Twentieth Air Force

APPROVED:

ROBERT L. STEARNS, Chief,
Operations Analysis Division
Twentieth Air Force

Incl:
Memo "Controlled Bomb.
Attacks on Jap. Targets"

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Office for Emergency Management

NATIONAL DEFENSE RESEARCH COMMITTEE

of the

Office of Scientific Research & Development

1530 P Street N. W.

Washington, D. C.

21 March 1945

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Operations Analysis Division
Twentieth Air Force
Room 4E-164, The Pentagon
Washington 25, D. C.

Attention: Mr. LeRoy A. Brothers

Dear Roy:

I am sending copies of the enclosed memorandum and of Hottel's and Wilson's letters accompanying it to the men listed below. This exhausts the copies that I have on hand, and I shall presently see you about further distribution.

Sincerely,

V. Rojansky

enclosure

cc: W. Bleakney, Princeton University Station, NDRC
H. C. Hottel, Division 11, NDRC
E. L. Moreland, Chairman's Office, NDRC
N. M. Newmark, Scientific Advisory Group
Lt. Comdr. W. W. Timmis, Joint Target Group
E. B. Wilson, Jr., Division 2, NDRC

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March 20, 1945

Rm. 4723, Munitions Building

Operations Analysis Division
Twentieth Air Force
Room 4E-164, The Pentagon
Washington 25, D. C.

Attention: Mr. LeRoy A. Brothers

Dear Sir:

I am forwarding a memorandum on "Controlled Bombing Attacks" prepared by Dr. V. Rojansky of the Division 2 - Division 11 group which is currently studying certain bombing problems. The material in this memorandum has been carefully discussed by a qualified group, who have approved its general recommendations.

In forwarding this report with the endorsement of Division 2, NDRC, I should like to add that the Division is very anxious to be of any possible service to your group.

Sincerely

E. Bright Wilson, Jr.
Chief, Division 2, NDRC

enclosure

cc: Dr. V. Rojansky

This document contains information affecting the national defense of the United States within the meaning of the Espionage Act, U.S.C. 50; 31 and 32. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

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March 21, 1945

Operations Analysis Division
Twentieth Air Force
Room 4E-164, The Pentagon
Washington 25, D. C.

Attention: Mr. LeRoy A. Brothers

Dear Sir:

The attached memorandum "Controlled Bombing Attacks" was prepared jointly by Divisions 2 and 11 with AN-23. The recommendations concerning incendiaries submitted by Section 11.3 were prepared after sufficient consultation within the Division and between the Division and Chemical Warfare Service Technical Command and Technical Division to constitute a fair consensus of opinion as to what type of controlled attacks would be most helpful.

Very truly yours,

H. C. Hottel
Chief, Section 11.3

CC: Dr. H. M. Chadwell
Dr. R. H. Ewell
Dr. V. Rojansky

HCH:srn

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21 March, 1945

The following memorandum represents the current views of Division 2, NDRC, and Section 11.3, NDRC; its writing was delegated to V. Rojansky of the NDRC Project AN-23.

## CONTROLLED BOMBING ATTACKS ON JAPANESE TARGETS

### I. SUMMARY

To do more damage to the enemy per ton of bombs we must know the effects of actual bombs on actual targets. This knowledge is now very scanty, especially for some bombs in our arsenal; and the improvement of future attacks is therefore delayed.

The necessary information can be obtained from attacks planned not only to produce immediate military results consistent with the effort, but also to provide a clear-cut basis for weapons analysis.

The following four types of "controlled" attacks on Japanese light industrial targets are recommended for immediate consideration:

a. 4000 lb LC bombs alone,

b. 500 lb GP bombs alone,

c. M69 incendiaries, together with 500 lb GP bombs,

d. M69 incendiaries, alone, except for markers.

Fuzing and other specifications are given in Section V, where this program is discussed in detail. The principal gains in methods of weapon selection that this program should yield are listed in Section VI.

Further types of controlled attacks are listed in the Appendix.

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## II. NECESSITY FOR CONTROLLED ATTACKS

Despite the relative success of recent bombing attacks on Japan and Germany, no substantial gains have been made within the past two years in the knowledge of how to choose the most effective weapon for air attack — knowledge based on experience in previous attacks. Basic issues still remain obscure; the effect of large blast bombs, cratering versus air-burst within buildings, the amount of incendiaries for use on industrial targets, the best incendiary for light industrial targets. These are issues on which opinion differs today even among experts in weapons analysis. Besides, there is the question of the difference between European and Japanese targets and passive defense measures.

Better knowledge of weapon selection can come from experience — but only if experience will throw light on the fundamental. If, without impairing the effectiveness of current operations, bombing attacks can be made to yield information for the more effective planning of subsequent attacks, then it is most important and urgent to plan at least some "controlled" attacks, so as to yield the greatest return in the long run.

## III. DEFINITION OF CONTROLLED BOMBING ATTACKS

A controlled attack is defined as one in which the structure of the target is known, and in which the weapons are selected in such a way that their detailed effects can be determined from the usual photographic cover plus certain additional information that can be gathered under operational conditions. In general, this means that not more than one type of HE bomb with only one type of fusing be carried in a given attack, combined with not more than one type of incendiary bomb.

It is apparent that most bombing operations can be "controlled attacks," and that control can be used without reducing the military effedtiveness of the operation. With the control, however, it becomes more feasible to identify the bomb that produces the damage, and to assess its effectiveness.

## IV. RECORDS NEEDED

For weapon analysis, written and photographic data are needed describing the target, the weapons, the attack, the bomb-fall and the damage. In order that attacks may yield the maximum of information, these data should be as accurate and complete as possible. All the photographic evidence should be made available for analysis; this point is emphasized, because in the past some of the photographs considered superfluous by Photographic Sections were later found to contain inportant clues for general analysis.

Attack records should include the formation pattern over the target, aiming points, bomb loading, bomb filling, time of release, method of release, intervalometer setting, altitude, ground speed, true heading, drift, track, wind speed and direction, method of sighting, and order in which bombs are dropped; the altitude record should show whether sea or land level is used as the base; the direction records should show whether magnetic or geographic North is used.

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Photographic records should include good stereo pairs of pre-attack photo cover (with sufficiently long shadows) and of post-attack photo cover (with sufficiently short shadows), in addition to sequences of strike photos. The scale of the photo cover should be 1/10,000 or better. To analyze the development of fire, post-attack cover flown within an hour of the attack is desirable in addition to that flown within a day or so, especially if incendiaries are involved. For each formation of attacking planes at least one sequence of strike photos is required, and more than one are highly desirable. The interval between frames should not exceed 3 seconds. Cameras of 24 in. focal length are preferable; they should be properly tilted to the rear, and the angle of tilt reported. Time reference should be recorded, if possible, on each frame. Exposure times should be adjusted on bomb run (as has been done at the Fifteenth AAF).

V. RECOMMENDATIONS

1. We recommend for immediate consideration the following four types of controlled attacks on light industrial targets in Japan (fuzing is specified below):

(a) 4000 lb LC bombs alone,

(b) 500 lb GP bombs alone,

(c) M69 incendiaries* together with 500 lb GP bombs,

(d) M69 incendiaries along, except for markers.

This program, described in detail below, was chosen because it appears quite practicable at present, and because the questions that it would help to answer are urgent. The records needed were listed in Section IV.

For a number of reasons, in pure HE attacks as well as in mixed attacks, the damage achieved per ton of bombs is bound to vary considerably from one attack to another, even if the bomb loads are the same and the targets similar. To obtain reliable conclusions the following numbers of attacks are regarded as necessary: three attacks of type (a), three attacks of type (b), five attacks of type (c), and five attacks of type (d); all should be on similar targets, and all of about the same ground density.

Operations circumstances may, of course, result in ground densities differing from those recommended below; spill-over would, however, provide information on bomb performance on further target types.

2. Weapon specifications. Throughout this recommendation the following specifications are implied:

4000 lb LC: fuzed non-delay tail, instantaneous nose;
500 lb GP: fuzed 0.01 nose; if this is not available, then 0.01 tail and 0.1 nose should be used;
M69: in M18 or E46 clusters.

Operational conditions will determine the intervalometer setting. If practicable, the filling of the 4000 lb LC's should be the same as that of the 500 lb GP's.



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*The M74, which is similar to the M69, is intended ultimately to replace the M69. If it should become available in sufficient numbers before the recommended program gets under way, the Air Forces may wish to substitute the M74 for the M69 in these recommendations.

3. Target Specifications. About 20 light-industrial Japanese targets should first be chosen and reserved for controlled attacks. They should be selected from the targets described in industrial target folios, should be quite similar in general construction, and each should be from 50 to 150 acres in area. Industrial-cluster targets, with light machine shops and assembly plants are recommended. The targets should have about 40% of the building area under combustible roofs and should preferably be virgin. Targets composed of a few very large building (that is, buildings having fire divisions over 200,000 square feet in plan area) should preferably not be included in this program.

4. Descriptions of attacks.

(a) Attacks with large HE bombs. Three of the selected targets should be attacked with 4000 lb. LC bombs alone. The recommended ground density to strive for is 1 ton per acre.

(b) Attacks with medium HE bombs. Three of the selected targets should be attacked with 500 lb GP bombs alone. The recommended ground density to strive for is 1 ton per acre.

(c) Mixed HE-IB attacks. Five of the selected targets should be attacked by M69 incendiaries together with 500 lb GP bombs. The recommended ground density to strive for is 0.5 ton per acre of the IB and 0.5 ton per acre of the HE. Each airplane should carry HE's and IB's in a fixed proportion, if this is operationally feasible.

(d) Almost-pure IB attacks. Five of the selected targets should be attacked by M69 incendiaries alone, except that each airplane should carry one 500 lb GP bomb — primarily to help in the difficult task of identifying the incendiary bomb-fall. The recommended ground density of IB's to strive for is 1 ton per acre.

5. Coordination of controlled attacks. For a fruitful cross-comparison of the performance of two different types of bombs in two different attacks, it is important to have a close similarity not only in the targets but also in the operational conditions; for example, if visibility over the one target should differ much from that over the other, then, besides the bombing accuracy, the quality of photographs would vary also, and comparison would be difficult.

The attacks in the present program should therefore be as closely coordinated as possible. The ideal plan would be to schedule one attack of each kind on the same day, and on targets in the same locality. Such a schedule, however, may be impracticable, and therefore we do not make it a part of our recommendation; but we do suggest that close coordination of the attacks — at least in pairs — be given careful consideration.

VI. IMPROVEMENTS IN WEAPON SELECTION

The controlled attacks recommended above should throw considerable light on

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some of the most important points in weapon selection that are still in the controversial stage.

Attacks of types (a) and (b) should make possible a comparison of the effects of a medium weight GP bomb and a large blast bomb on light industrial construction — and also on domestic construction that is likely to be present in the targets specified. In addition, any over-all differences between Japanese and European targets could be established by comparing the ratio of damage areas of the two bombs on Japanese construction with the corresponding ratio for the same bombs on European construction.

These attacks should also provide a basis for estimating the blast intensity required for the destruction of Japanese installations; reasonably confident predictions on the effects of T51-fuzed bombs and on their optimum size can then be made also.

Attacks of types (b), (c) and (d) should shed much light on the vexing problem of optimum HE-IB loads for use on industrial targets. The currently available information is inadequate for at least three reasons: it is meager; it does not cover the higher densities and the higher IB-to-HE ratios; and it comes mostly from ETO and may therefore be unsafe to apply to Japanese targets.

Attacks of types (c) and (d) should also elucidate in a realistic way the questions on the interaction between high-explosive and incendiary bombs.

## APPENDIX

The number of unsettled issues in weapon selection is large, and the current disagreements among experts indicate not so much a bias but rather a genuine lack of definitive information. Among the more important questions — besides those listed in Section II — are questions concerning the fuzing, including proximity fuzing; the comparison of different high-explosive fillings; the relative effectiveness of large and medium HE bombs, weight for weight, in causing spreading collapsein buildings; the effect of the detonation of one HE bomb in a building on the performance of the next HE bomb hitting the building; the comparison of medium and heavy GP bombs on heavy industrial buildings; the relative effectiveness of blash and ground-shock against heavy industrial buildings; the relative effectiveness per airplane load, of different incendiaries on various target types; the contribution of fire spread to total damage in Japanese targets; and, of course, the optimum combinations of bombs in mixed HE-IB loads.

Some of these questions can best be decided by controlled attack, carefully planned to yield the maximum of useful conclusions without decreasing the immediate military value of the attacks themselves. Four types of controlled attacks of high priority were recommended in Section V. Certain other controlled attacks are advisable — some of them on fortifications and underground installations. The list below refers to industrial and domestic targets and includes the recommendations of Section V, except that, for brevity, mixed HE-IB attacks are not listed.

1. High-explosive bombs on light industrial and domestic structures (controlled HE attacks should provide for comparison of bomb fillings):

   i. Medium bombs: 500 lb GP, fuzed 0.01 tail and 0.01 nose;

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ii. Medium bombs: 500 lb GP, fuzed 0.01 tail, long-delay nose;

iii. Large blast bombs: 4000 lb LC fuzed non-delay tail, instantaneous nose;

iv. Very large blast bombs: the British 8000 lb HC bomb is probably the largest that can be carried without extensive modification;

v. T51-fuzed 4000 lb LC bombs.

2. Incendiary bombs on industrial and domestic structures (HE markers are needed in almost-pure IB attacks to establish bomb-fall):

i. AN-M50 4 lb magnesium bomb;

ii. AN-M69 6 lb gasoline gel bomb;

iii. M74 10 lb pyrotechnic gel bomb;

iv. AN-M47 70 lb gasoline gel bomb;

v. AN-M76 500 lb pyrotechnic gel bomb.

3. High-explosive bombs on heavy industrial structures:

i. 2000 lb GP bombs fuzed 0.01 tail, 0.1 nose (0.01 nose if available);

ii. 2000 lb GP bombs fuzed 0.1 tail, 0.1 nose;

iii. 500 lb GP bombs fuzed 0.01 tail, 0.01 nose, if available;

iv. 500 lb GP bombs fuzed 0.1 tail, 0.1 nose.

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Mass. Institute of Technology
Building 23
Cambridge 29, Mass.

May 23, 1945

Dr. Robert L. Stearns
Chief Operations Analysis Division
20th Air Force
Room 4E168 Pentagon Building
Washington 25, D.C.

Dear Dr. Stearns:

My letter of May 10th to you contains a typographical error in the fourth paragraph of Page 2. The final sentence of that paragraph should read:

> "Preliminary analysis indicate that the turn resulting from a 6° bank and/or a 10° climb or dive will be permissible without serious interference with accuracy."

Since my return from a trip of about two weeks, I have seen a memorandum of 15 May on this general subject addressed to/from you Dr. W. N. Tuttle, Mr. A. C. Bemis, Director of the Heat Research Laboratory of M.I.T. has made responsive comments as regards Felix in a memorandum, a copy of which is attached hereto.

As regards Razon we feel that the emphasis seems to have veen placed on tonnage of bombs dropped rather than on the destruction of the target. While it is true that the very great advantage of Razon comes from its use against small targets, we feel that its use will be profitable, in terms of tonnage expended and of risk to aircraft and personal, whenever a specific target is to be destroyed rather than an area to/be interdicted.. This we feel to be important in theatres where the problem of transport is acute.

We believe that a squadron of 12 aircraft dropping and guiding one Razon each should be able to place three bombs in each quarter of a target 1000-feet square from 25000 feet in a high percentage of cases. Four analysis are doubtless able to estimate the number of bombs required to accomplish the same effect by conventional methods. We recommend the use of such a squadron against a succession of targets rather than successive passes on salvoing over a single target.

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It is expected that data on the operation of Razon at high altitudes will be available in approximately 45 days. In connection with the experiments developing this data we expect to determine the limits which can be placed on evasive action - checking our analytical findings.

In regard to Azon, it should be pointed out that its error in range is not greater and may be rather less, than that of standard bombing since the bombardier is able to concentrate on killing the rate in the bomb sight knowing that he will have an opportunity to "second guess" in azimuth.

If there are further questions regarding these missiles, we should be most happy to discuss them with you. It is my plan to be in Washington on 30 May and Mr. Bemis could easily join me for a meeting with you or any of your group.

Very sincerely yours,

Hugh H. Spencer, Chief
Division 5, NDRC

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Memorandum to : Mr. H. H. Spencer, Chief, Division 5, NDRC

From : A. C. Bemis, Heat Research Laboratory., M. I. T.

Subject : Comments on memorandum by W.E. Tuttle, Operations Analyst, Twentieth Air Force

The Significant points raised in parapraphs 2-a through 2-c appear to be summarized in the last sentence of 2-a; "Suitable targets must not be too large, or the advantage of Felix would be lost, or too small, as in the latter case sufficient radiation would not be obtained."

First we would like to pint out that this argument does not apply to certain special targets such as blast furnaces and coke ovens which are small as far as direct hits are concerned byt which radiate large quantities of hear and make excellent Felix targets.

Second, we believe the advantage factor of Felix is decreased but not lost with large targets. The practice target constructed at Orlando is a square area 1600 ft. on a side containing an array of cleared areas representing roads and buildings. Surveys have shown this target to be inferior to all industrial targets which we have rated as satisfactory. In spite of this difficulty, 30 Felix bombs have homed on this target up to April 1, 1945, 28 of them hitting within the target area. Of these 28, 17 made direct hits ont the two largest"buildings." One of these buildings is 250 x 400 ft., the other is 300 x 500 ft. We have not seen any strike photographs showing such a pattern with standard bombs.

We agree with one of Mr. Tuttles points in parragraph 2-d, that the essential factors limiting the choice of targets for attacks by Felix must be consistently borne in mind in the operational planning of missions. The other point, that these factors must be better known, is questioned. Sixty-eight industrial targets in this country have been surveyed with a Felix survey device, several of these 8 or 10 times under different times/ofday, different seasons, and different weather conditions. In addition, other heat surveys have been made of at least as many other industrial targets. Half of these surveys have been completely analyzed. The other half are being analyzed. In assisting the Joint Target Group with their selection of Japanese targets suitable for Felix all targets were turned down where the aerial photographs showed any possibility of disturbing thermal influences.

In short, those of us who have had a chance to observe the Felix program closely believe the Joint Target Group's conclusion that the Felix advantage factor on suitable targets is 2 to 1 is a very conservative conclusion.

A.C.B.

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CST/W.N.TUTTLE/rab/4819

26 May 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, SHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE

Subject: Reply to Comments of A. C. Bemis on Felix Program

1. The conclusions reached in the memorandum of 15 May related soley to the question of the anticipated increase in the effectiveness of the Twentieth Air Force operations against present priority targets. On this basis it is not believed that the initiation of a Felix program can be justified by any results that can reasonably be expected.

2. From the standpoint of the weapon development program, on the other hand, it seems highly important that present survey data on heat patterns be supplemented by bombing tests under standard operational conditions against selected strategic targets. It is believed important that any program be undertaken with a clear understanding that it is for experimental purposes, in order that results may not react unfavorably and prevent the use of the equipment later in operations where it could be highly effective.

W. N. TUTTLE
Operation Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

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16 November 1944

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Report on Discussions on and Demonstration of M69 Airable Incendiary Cluster at Bayway Refinery, Standard Oil Company of New Jersey on 14 November 1944.

1. Upon request of Commander Bitter of the Joint Target Group, dated 9 November 1944, and under orders, dated 13 November 1944, copy of which is attached, the undersigned attended a meeting at the Bayway Refinery of the Standard Oil Company of New Jersey. The purpose of the meeting was to discuss the use of incendiary bombs, specifically the M69, for the bombing of Japanese targets.

2. The meeting started at 0930 EWT, 14 November 1944. Present were thirty-two (32) persons, representing Standard Oil, NDRC, OSRD, OFS, Chemical Warfare Service, Air Chemical Officer, Joint Target Group, OAD, Twentieth Air Force, and British Incendiary Bomb Mission. The meeting was presided over by Dr. E. F. Meyers, of the Standard Oil Company. Among the prominent members of the various delegations were:

| | |
|---|---|
| Standard Oil Company | Messrs. Roediger, Richards, and Fox |
| NDRC | Dr. Ewell, Mr. Horatio Bond |
| OSRD | Professor Hottell (MIT) |
| Joint Target Group | Major Crowther |
| British Group | Group Captain Mitchell, Wing Commander Wellner, Professor Finch, Mr. Alder. |

3. The meeting fell into three parts:

a. (Morning session 0930 - 1145). Discussion of properties of M69 incendiary cluster.

b. (Morning session 1145 - 1300). (Afternoon session 1400 - 1545). Discussion of moisture contents and inflammability of Japanese structures.

c. (Afternoon session 1550 - 1700). Field demonstration of M69 bombs.

4. Certain portions of the discussion, presented by the Standard Oil Group, were distributed to the participants in the form of tables and figures. This material is attached hereto. The gist of the discussions,

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exclusive of the Standard Oil Material, and my personal impressions of the field tests are also attached in a separate report.

5. In general, I got the impression that this was a "sales" meeting on the part of Standard Oil. The view point of the consumer was again neglected. Considerable argument was based on tests that could not contribute to the argument. Much of the argument seems to me to be academic and the ultimate solution is, of course, the test run over a target.

H. D. LANDSBERG,
Special Consultant.

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REPORT ON DISCUSSIONS ON AND DEMONSTRATION OF M69 ALLABLE INCENDIARY CLUSTER AT BAYWAY REFINERY, STANDARD OIL COMPANY OF NEW JERSEY ON 14 NOVEMBER 1944.

by H. E. LANDSBERG
Operations Analyst, OAD, Twentieth Air Force

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A. Discussion on the properties of M69 bombs.

1. Data were first presented on the functioning of the M69 and their comparative properties with respect to other types of incendiaries. The data are contained in tables 1 and 2 of the material presented by the Standard Oil Company Group. There was little discussion of these data; general concensus seemed to be that M69 as such is an efficient incendiary bomb.

2. Data concerning the addition of white phosphorous (WP) to M69.

a. The results of these tests are shown in table 3 of the attached ESSO document. The discussion centered around the advisability of adding WP to incendiaries. The ESSO representatives stressed the point that WP, producing a dense smoke, would obscure a fire to such extent that it would make it difficult to find and hence fight fires started in a room. According to their tests, obscuration in an ordinary dwelling room is complete in forty-five (45) seconds after bomb enters. In the ensuing discussion this effect was largely discounted as of significant importance. Especially the fire engineers present seemed to be inclined to believe that an efficient fire fighting force would be able to extinguish the fire anyway.

b. More important was, according to Professor Finch and others, the physiological effect of the WP smoke, which would necessitate for fire fighters to wear a mask. This reduces the efficiency of the fire fighter. It was further considered improbable that the individual householder would have mask available.

c. Of further importance is the property of WP to re-ignite structures after the fire has been extinguished, even if relatively small traces remained. This was attested to by an unfortunate accident that happened to a structure erected by ESSO. It was a building simulating a German house. A test was performed with a M69 bomb to see how the attic would burn. The fire was extinguished and the obvious remainder of the bombs removed. This happened at 1700 of a given day. No fire remained at that time. At 2000 the building was again in full flames. Apparently due to remnants of WP and in absence of a fire watch in the early stages of the second fire the structure was completely lost because the fire was out of hand.



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d. The writer raised the question if not the addition of WP to the incendiary would increase the smoke produced by the fire and thus make bombing for later formations more difficult by obscuring the target. WP smoke is particularly dense and more persistent than other smoke. In fact, in high humidities, it will lead to the formation of fog. Major Crowther and Wing Commander Wollner stated that they thought the target would be obscured by fire smoke anyway and the later formations would have to bomb by aids, such as radar and target markers.

3. Data on addition of High Explosive (HX) to M69.

a. Data on tests carried out on M69X bombs are contained in tables four through six of the ESSO document. The fuses for the HX are of delayed action type. At present bombs with 1/2, 2, 4, and 6 minute delayed fuses are being considered. Even if the casualty producing capacity of the HX is limited, as the British delegates seemed to think from English experiences, the psychological effect on fire fighters cannot be underrated. This includes the noise effect of the detonation.

b. With Japanese type structures, where no thick walls offer protection, a considerable number of fragments will scatter through wooden panels.

4. Discussion on most desirable type bomb.

a. ESSO asked for an expression of opinion as to what the most desirable combination of load for the M69 would be.

(1) Incendiary gel only.

(2) Incendiary gel plus WP.

(3) Incendiary gel plus HX.

(4) Incendiary gel plus WP plus HX.

b. General concensus of opinion was that combination (4) would be most effective, although British representatives raised the question if reduction weight of gel because of addition of WP and HX would not reduce fuel to an extent to make ineffective what they seem to consider a "marginal" incendiary bomb anyway.

c. Professor Finch pointed out, with general approval, that the effectiveness of added WP and HX is not just additive in terms of performance, but liable to be more important because it would not only add the necessity of masks for fire fighters but also make it hazardous to enter the area of the bomb with an unknown delay on the HX action. No effective countermeasure could be taken because the delay on the fuse, whether 2, 4, or 6 minutes, would be

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unknown to the fire fighters. He would be reluctant to fight the fire until it had gone off.

B. Discussion on moisture content and inflammability of Japanese structures.

1. ESSO representatives presented data on moisture contents of various types of wood under varying climatic conditions together with their interpretation of these data for Japanese targets. They also commented on the Dugway (Utah) tests and their reliability for deductions. In view of the fact that the British tests on inflammability at Watford had yielded entirely different results, the ESSO representation was in main a defense of their own tests.

2. The resulting argument between ESSO personnel and the British delegates centered mainly around the problem of what moisture content was present at the various tests and if the amounts assumed to be present would be representative of conditions in Japanese cities. Data of ESSO calculated values are shown in figure 5 of attached ESSO document.

3. Matters of argument (without sufficient facts on hand for intelligent discussion, in the writer's opinion) are:

a. (1) What is wood moisture?
(2) How deep do changes in the relative humidity of the air penetrate into the wood? How rapidly do environmental changes affect the wood?

(3) What moisture content of the surface layers of wood is critical for inflammability?

(4) Are outdoor relative humidities and temperatures representative for humidities indoors? Do occupancy and living habits change the humidities? Do they raise or lower it in rooms and attics?

b. Professor Finch suggested that only the moisture content of the first 1/8 to 1/4 inch is important for inflammability. Dr. Hottell thinks that 1/2 inch is the layer affected primarily by outward humidity changes. The ESSO people think that the monthly mean relative humity can be taken as representative to obtain wood moisture content. Dr. Hottell is inclined to believe that four- to five-day periods would be more appropriate; i. e., the wood responds more rapidly. Also, in his opinion, insolation is an important factor.

4. The writer pointed out to the meeting that neither Dugway nor Watford could be taken as generally representative of Japanese climate conditions. The coastal plain of North Carolina would be a great deal more representative. He also pointed out that the day by day changes of humidities are large and if wood response is rapid, that would be an important factor. In that case, only if the values



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on the days when tests are made and the days the targets are hit (and the days immediately preceding) are alike will these tests have any significance to predict the response of structures in the target area.

5. Also, in the writer's opinion, conclusions from tests are valid only if continuous humidity records, by hygrographs, for all of the following are taken:

a. The outdoor air for many days preceding the tests and during the tests.

b. Simultaneously, the indoor air in various parts of the structure.

c. Simultaneously, for woodwork in various parts of the structure, at varying depths of the wood.

C. Field demonstration of M69 performance.

1. Altogether five tests were shown.

a. M69 containing gel only, fired into open grassland, from mortar.

b. M69 containing gel and WP, fired into open grassland, from mortar.

c. M69 containing gel, WP, and HE, detonated statically inside a large wooden box (about 4 x 5 x 5 feet).

d. M69 containing gel, WP, and HE, detonate statically inside simulated Japanese cottage. Two tests.

2. Noted in the first two tests were the considerably larger production of smoke from bomb containing WP. Both produced considerable grass fires.

3. Noted in the third test was the explosive effect of HE on box, with fragments blowing through walls. Also the dense smoke inside box and the rapid spreading of the fire. However, $CO_2$ fire extinguishers brought fire under control rapidly.

4. Noted for the first static test inside the Japanese structure was the fact that the bomb was blown right through the wall of the building (no luster on the inside). None the less, the gel was spread against the outside wall and a substantial fire was started. This fire was about five minutes later controlled by a directed stream from a stirrup pump. About two to three gallons of water sufficed to control the fire (estimate of Mr. Bond). This raises the



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interesting points of effectiveness of these bombs. Normally, only roof hits are considered to be effective to produce fires. The scattering of the gel in this case from the outside on the walls suggests that even hits between houses will have some effect, ranging for distances of at least five and perhaps ten feet away from the side of the house.

3. In the second static test inside the Japanese house, the bomb exploded on the inside and a tremendnous fire enveloping the whole house was started within about two minutes. A stream of heavy water from two hoses was brought to play against the fire about five minutes after the fire started. About eighty gallons of water (again an estimate of Mr. Bond) brought the fire to extinction. However, the whole structure was completely charred and obviously in reality the house would have been a complete loss.

D Some personal conclusions.

1. Considerable time would have been saved, had the persons in charge of the tests consulted a meteorologist before starting the tests. They might have immediately obtained data on most comparable climatic conditions in this country for various target areas.

2. The present tests are inconclusive and a matter of opinion. They should be repeated with the procedure outlined in C3 above; preferably in a North Carolina area comparable to Japanese conditions. Wood samples from a Japanese type structure, as available in some western sections of the U. S., i. e., a Japanese garden in San Francisco, California, might help to determine what the moisture content of these structures is in an aged condition, rather than just newly built ad hoc for the tests.

3. The use of phosphorous powder in the bomb will lead to serious interference with visibility. I think Dr. Youden's opinion should be obtained on this point to determine if the unfavorable aspects of this for precision bombing might not outweigh the advantage from the viewpoint of the "fire spreaders."

4. The attitude of the people connected with this project is unrealistic. They do not consider the problem of laying the bombs on the target. With the usual raid technique it probably matters very little what type of bomb is used, if the bombs land on the target. No matter how efficient the incendiaries are, if the target is not hit, love's labor is lost.

W. E. LANDSBERG
Special Consultant.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

18 November 1944

A NOTE FOR THE INFORMATION OF:
DR. H. E. EWELL, N.D.R.C. (THRU: JTG)

Subject: Pertinent Meteorological Information For Tests of M69.

1. Reference is made to our telephone conversation of 16 November 1944 in which you stated that tests on M69 are to be repeated in an area where the climatological conditions during the next three months are comparable to those normally prevailing in Tokyo from June through August.

2. Records of normal conditions for Tokyo, June through August, are given below, and for somewhat comparable stations in the western hemisphere, December through February. The two approximations chosen are Key West, Florida, and San Juan, Porto Rico. In many respects, the Porto Rico data are more comparable to the Tokyo data for July and August.

3. It should be pointed out that important differences exist. In Key West, the amount of rainfall, the number of rainy days, are considerably less than those normally prevailing in Tokyo during the months in question. Wind speeds are slightly lower in Tokyo than in both Porto Rico and Key West. On the other hand, cloudiness is less and sunshine is more in some of the months at the two western hemisphere stations than at Tokyo. The rate of evaporation at Porto Rico in February is roughly comparable to that in Japan (Tokyo) during the summer.

4. Mean data are as follows:

| | Tokyo | | | Key West, Fla. | | | San Juan, P. R. | | |
|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Dec. | Jan. | Feb. | Dec. | Jan. | Feb. |
| Mean Temp Deg F | 68 | 75 | 78 | 70 | 70 | 71 | 76 | 75 | 75 |
| Mean Max Temp Deg F | 76 | 83 | 85 | 75 | 74 | 76 | 81 | 80 | 80 |
| Mean Min Temp Deg F | 63 | 69 | 72 | 66 | 65 | 66 | 71 | 70 | 69 |
| Mean Rel Hum % | 81 | 83 | 82 | 78 | 79 | 76 | 79 | 78 | 77 |
| Mean Dur. of Sunshine (Hrs) | 153 | 195 | 209 | 184 | 195 | 204 | 218 | 217 | 222 |
| Amt of Precip (In) | 6.4 | 5.5 | 6.4 | 1.7 | 1.8 | 1.5 | 5.4 | 4.2 | 3.7 |
| No. Days Precip | 16 | 14 | 13 | 7 | 8 | 6 | 22 | 21 | 15 |
| Evaporation (in) | 3.6 | 4.7 | 5.1 | - | - | - | 5.5 | 5.6 | 5.5 |
| Mean Wind Vel (Mph) | 8.1 | 8.1 | 8.1 | 10.6 | 10.6 | 10.6 | 11.3 | 12.5 | 11.6 |

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Meteorological Information (Cont'd).

5. There is, of course, no guarantee that the coming December through February at the western hemisphere stations is normal or that it will be at all comparable to next June through August at Tokyo.

H. E. LANDSBERG,
Operations Analyst.

P.S. Note that other places in general region of Key West have entirely different conditions from Tokyo.

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7 June 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE.

Subject: Use of the Fire Wind For Incendiary Attacks.

1. It is a well known fact that large conflagrations create intense up-drafts. This results in strong winds rushing toward the burning area from all sides. This is proven by observations from large forest fires and city fires. Some pertinent quotations are attached. Similar observations have been reported from Germany, subsequent to aerial incendiary attacks of the RAF. Lately, Japanese reports of effects of the B-29 incendiary strikes indicate clearly that intense winds, for which no reasonable meteorological explanation can be given, were observed.

2. The evidence on hand indicates that an intense fire can create winds of gale force, rushing into the fire area from all sides. It is likely that winds in excess of 50 miles per hour are being created in the immediate vicinity of the fire and that winds of half that force will probably exist to at least a mile away from the fire.

3. Such an intense wind, while completely burning out everything within the fire area, will at the same time prevent fires from spreading beyond it, unless very strong natural winds accompany the fire also.

4. At an earlier occasion (October 1944) a special tactic was suggested to take advantage of the fire wind to obtain maximum effect by incendiary attacks. This suggestion is now repeated, particularly in view of the fact that during the next two or three months rather small natural wind speeds at the surface in most of the important Japanese target areas can be expected. The wind will be the most important single atmospheric factor helping to spread fire in Japanese cities in this season because all other elements, especially humidity and rainfall are likely to affect fire spreading adversely.

5. The Tactical procedure suggested is as follows:

a. Have a first very concentrated attack on a relatively small area with the highest possible concentration of incendiaries made. This will create the fire wind.

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b. Follow this attack, as soon as the fires can reasonably be expected to take a hold on the area, by a second one that is to lay a ring of fires around the central concentration, particularly toward the windward side in order to take advantage of whatever natural wind might exist.

c. The fire wind created by the initial fire can be expected to draw the fires created at a distance, probably not to exceed 1/2 to 1 mile, toward the central area and burn out the intervening section.

6. A success of t is tactic will not only help to increase the area affected by fires, but it might in many instances, tran fire-fighting equipment and personnel. These will be rushed to the initial fire but may become singed by the other fires started around this initial area and escape may become difficult if not impossible.

7. It is realized that it may be difficult to lay down a bombing pattern creating a central fire with a ring of fir s around it but it seems worth trying to achieve this pattern in view of the much higher effectiveness that can be expected from this type of pattern.

8. Because of the relative accuracy required to lay down the desired pattern, this type of operation will need visual bombing conditions with specific different aiming points assigned to the various formations attempting to apply this procedure.

HELMUT E. LANSBERG
Operations Analyst

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CASES OF HIGH WINDS CREATED BY LARGE FIRES

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Case 1: 14 October 1918 - Duluth, Minnesota - Forest Fire
(burned 1500 square miles, 1000 lives lost)
"The fire was attended by a tremendous gale, probably to a large extent created by the fire itself, as the meteorological conditions favored but a fresh wind. During the worst period of the fire the wind blew at rates varying from 50 to 65 miles per hour".

Mo. Wea. Rev. 46, 1918, 508 (Herbert Lyman)

Case 2: (1899?) - Large Lumber Mill in Minneapolis was destroyed by fire.
"The general movement of the wind on that day was very slight, but the surface winds were quite fresh, blowing in toward the fire on all sides. This I know, because I went completely around the fire for the purpose of ascertaining if such was the case;;;... .....The movement of the suface winds on all sides of the fire is an important factor to be considered, especially in the case of very large fire".

In Signal Corps records on forest fires in Michigan it was noted that "the wind force close to the fire was reported to be very stron, whereas the barometric gradients at the time indicated only light winds. I sometimes think that the winds engendered by fires of this character have a tendency to increase the area burned over, as well as the intensity of the fire, by thus supplying abundant oxygen to the burning pile."

Mo. Wea. Rev. 47, 1919, 144 (R. A. Peak)

Case 3: Chicago Fire 8,9 October 1871.
8 October 1871. Up to 12 PM fire had been extended, and with no great velocity, merely by cont ct with the flames. But by 1 AM heat had become very intense and wind blew straight toward the fire in all directions. Within 40 yards of the blaze I estimated the wind toward it at 30 miles an hour... The wind by 9 AM (9October 1871) had increased to perhaps 25 miles an hour, at the distance of 3 miles to the southwest of the fire. In the immediate vicinity of it, especially in streets running east and west, it was blowing with the force of a hurricane... The wind blowing in alldirections toward the fire, confused some people in their endeavor to escape... As soon as fires had gathered in force not a single drop of water (from fire fighting services) could reach it. The wind swept it aloft.

The Weather & Climate of Chicago, Univ. of Chicago Press (1914), 367-369, ( H. J. Cox and J. H. Armington.)

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The Factor of Bomb Size in Incendiary Bomb Effectiveness, with Particular Reference to the M-76 500 lb. Bomb.

Given any quantity of incendiary fuel to be dropped upon a target, should the fuel be distributed in the form of a relatively small number of very large bombs, each capable of prolonged and intense heat evolution, or should it be formed into a large number of small bombs with shorter and less intense periods of flammability? To decide this question, we must consider the following facts:

a. Every target which is vulnerable to fire contains varying proportions of so-called "heavy fuel", such as wooden structural members of 2" x 4" cross-section or heavier, and of "kindling", such as light wooden panels, benches, Stacked crates, stores of paint, solvents, and the like.

b. It has been found in numerous trials that to initiate a destructive fire in "heavy fuel" by the direct action of an incendiary weapon is very difficult. Even the largest practicable sizes are unsatisfactory in the absence of sufficient proportions of kindling; for example, the 600 lbs. of fuel in the Napalm "fire bomb" jettisonable gasoline belly tank used by fighter planes has repeatedly failed to destroy the timbers of wooden bridges, because of the absence of Kindling.

c. If kindling is present, it is found that as little as 1/2 lb. of fuel is often sufficient to ignite it, and in no case is it necessary to expend more than about 2 to 3 lbs. of fuel in accomplishing ignition. If this amount is insufficient, the material cannot properly be classified as "kindling", and a growing, vigorous fire probably cannot be started in it with any reasonable amount of fuel. Hence, it is concluded that there is little to be gained by disseminating fuel in pieces weighing more than about 3 pounds.

d. In modern industrial buildings such as make up the majority of important strategic bombing targets in Germany and Japan, the areas which are favorable to the initiation of a destructive fire (by reason of the presence therein of kindling) are relatively small compared to the areas of such buildings as a whole. In the usual high priority target building measuring 150 by 300 feet, having a total area of 45,000 square feet there is often not more than about 20% of the area or 9,000 square feet which is occupied by material classifiable as "kindling". Moreover, this gross fire-vulnerable area will usually be made up of numerous small



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fire centers measuring from a few feet up to not more than 45 to 60 feet in diameter. It will be appreciated, therefore, that a wide distribution of incendiary fuel is necessary in order to search out and ignite a sufficient number of fire centers. This requirement, of course, further penalizes the distribution of incendiary fuel in a few large pieces. It will be seen that no matter how large a quantity of fuel we may put into a single container for release from an airplane, it must eventually be separated into pieces of a certain optimum size to be of maximum effectiveness.

The next question is: Shall the incendiary fuel be pre-formed into pieces of the proper size, which can be separated in the air after release, or shall the separation be delayed until the instant of impact? It is evident that the M-76 and M-47 bombs differ more critically from the M-17 cluster of M-50 bombs in the manner of manner of separation of the fuel, than in any specific difference in the sizes of the fuel deposits actually spread over the target. The peculiar distribution characteristics of these weapons can now be considered:

Firstly in cluster-type bombs, the pieces of fuel can be positively fixed at the approximate optimum size, whereas in bursting type bombs the size of the lumps of fuel produced is variable, depends upon the target construction, and cannot be controlled within narrow limits. Thus, against concrete roofs the fuel in the M-76 bomb may be broken up into only a few lumps, of 5 to 30 pounds weight, while under other circumstances a high proportion of it may be shattered into minute pieces which burn out in a few seconds.

Secondly, bursting-type bombs, being generally of greater weight, are capable of penetrating certain types of roofs which successfully resist the impact of smaller bombs. Surveys have shown, however, that the great majority of industrial roofs are easily penetrated by the 4 lb. bombs, which will go through at least four inches of concrete if dropped from above 10,000 feet.

Finally, the dispersion of the filling in a bursting-type bomb takes place in a more or less horizontal plane at ground level, and is therefore capable of being limited or entirely defeated by the presence of vertical walls, partitions, or other barriers. It is here that we find the one really serious disadvantage of all large bursting-type incendiaries, as will be clear from the discussion following.

Experience has shown that the sizes of group bombing patterns do not vary significantly from one size of bomb to another, so that the different numbers of bombs of different sizes constituting a

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group load can be expected to be distributed over approximately equal areas of a target. In a 12 plane B-17 group pattern, for example, the pattern area per 500 lb. bomb averages roughly 38,000 square feet. That is to say, one M-76 bomb must be relied upon to search out and ignite all the fire centers lying within each 38,000 square feet of the group pattern area. Let us now examine how well fitted the bomb is to do this, considering first only the question of near-misses against industrial buildings.

In our example, we have taken a case in which one M-76 bomb is responsible for the ignition of all fire centers in an area of 38,000 square feet, which is equivalent to a circle of 110 feet radius with the bomb at its center. Now suppose that this center, representing the point of impact of the bomb, is placed adjacent to and just outside the wall of a brick, concrete or corrugated sheet iron building containing combustible stores. Obviously, no fire will result, because the wall will prevent the fuel in the bomb from reaching the interior of the building. In fact, even if the wall were made of wood, (a very uncommon situation in Germany and Japan) the initiation of a satisfactory fire would be unlikely, because of the absence of kindling and lack of any favorable point of lodgement for the fuel.

Now, in this same example, suppose one M-17 cluster is substituted for the M-76 bomb. There will then be 110 4 lb. bombs distributed more or less uniformly over the 38,000 square foot area, and if its center lies close to the building wall roughly half of them will, on the average, fall inside the building. In short, the presence of the building wall utterly defeats the distribution of the M-76 fuel, from a near miss, whereas it has no effect upon the distribution of the 4 lb. bombs.

Inasmuch as the expectation of a direct hit by an M-76 is governed by the laws of probability, just as in the conventional problems of bomb aiming, it is possible to apply mathematical methods to determine exactly what advantage the 4 lb. bomb has over the M-76. Such a study shows that even buildings as small as 30 feet square are virtually certain to be hit at least once if they lie within a group pattern of 4 lb. bombs, whereas buildings up to 60 feet square, <u>having four times</u> as great an area, will be hit <u>less than 10% of the time</u> by a comparable pattern of M-76's.

It may be objected at this point that important buildings are usually far larger than 60 feet on a side, which is quite true. However, even buildings as large as 180 feet on a side are likely to be hit by <u>one</u> bomb only about 60% of the time in a pattern of M-76's, while with 4 lb. bombs they will be hit, on the average, <u>about 94 times</u>. So great, then, is the difference in the methods of fuel distribution between clustered and bursting-type incendiaries.

There will, of course, be many instances of direct hits by M-76 bombs on the larger industrial buildings, and we may now consider the effect of internal partitions, walls, and machinery and equipment in



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the distribution of fuel from such hits. It must be admitted that an M-76 bomb, bursting within a building and within a room of that building where kindling is present, will frequently ignite the kindling with greater rapidity and certainty than will a few 4 lb. bombs, as there is then a definite over-dosage of fuel well above the economical level necessary for ignition. Here again, however, the chances of the occurrence of such an event are greatly reduced by the presence of interior walls and other distribution barriers, and by the wide spacing of the individual 500 lb. bombs. Unless the room is more than 60 feet square, the chances of hitting it are no better than 10%, just as in the case of an individual building of that size. It seems evident that a great many excellent fire centers, such as paint shops, woodworking shops and storage rooms will customarily occupy spaces as small as, or smaller than 60 feet square, while being a part of very large buildings. The partitions dividing the interior of a building are most frequently similar in construction to the outer walls, i.e. generally non-combustible in German and Jap targets, while the roofs are more commonly made of wood. The involvement of a wooden roof in a spreading fire cannot be counted upon, however, unless there is adequate kindling beneath it.

Everything which has been said herein with reference to the M-76 bomb is true in lesser degree of the M-47 bomb, except that the sizes of the lumps of fuel produced by the latter are somewhat more uniform and longer-burning. Hence, the present tendency among target analysis personnel is to advise against the use of the M-76 bomb for any high altitude attack, and to restrict the use of the M-47 to targets composed of very large buildings. In fact, it is not now possible to suggest any type of target against which the M-17 cluster is not at least as good as the M-47, and the latter seems destined to suffer a gradual withdrawal from service.

This discussion has dealt only with high altitude bombing attacks. For minimum level attacks by fighter-bombers, the chance of hitting factor desappears and the M-76 is by all odds the best choice. The smaller bombs do not stabilize well at low levels and lack sufficient penetration for horizontal approach to a building.

J. CROWTHER
Major, CWS

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11 June 1945

RESEARCH AND THE ARMY AIR FORCES

1. There is general agreement among all concerned with the security of the nation that research is a necessary adjunct to all measures of preparedness. In order to plan intelligently how to incorporate research into the national effort during the war and in the post-war period it is necessary, first of all, to define the term research as it applies to problems of national defense. There is hardly a word that has been misused more often than "war research". It has covered anything and everything from systematic attempts to create new weapons to routine compilation of records from the files; from testing of new models to arguments about size changes on screw threads. Every conceivable type of work that had a remote tinge of science or technology, to the most advanced investigations, has been lumped together under the general heading of "research."

2. Before one can attempt to properly integrate research into military plans and operations, it is necessary to classify research work, efficiently delineate various functions and see where they fit best into the existing military organization. It is by no means easy to succinctly separate the various activities that can justifiably be classified as research. However, an attempt can be made and a grouping of the following nature might be acceptable:

a. Fundamental research.

b. Applied scientific, technological and engineering research.

c. Testing of research and development results.

d. Analysis of operations.

3. a. Under fundamental research we understand the advancement of the frontiers of knowledge. It is conducted without regard to the immediate usefulness of the knowledge thus gained for any practical purpose. However, rarely have significant advances in fundamental knowledge made in the past failed to become of practical significance sooner or later. The lag in time between the instant of discovery of new facts to the time these facts acquire a bearing on practical questions is extremely variable. Some times only months elapse before the new knowledge becomes useful for a purpose on hand, at other times years or even decades might elapse. Many a case could be quoted where the "starry-eyed dreamers" hit upon new things years before anybody in the so-called practical world could find any use for them.

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b. There is hardly a field in the physical and biological sciences which has not sooner or later found its way into activities connected with warfare. To name but a few: From the Geissler tube of 60 years ago to radar was a long path; from Lilienthal's kites to the military glider of today 50 years of development have elapsed; from Fleming's discovery of the mold extraction penicillin to the effective clinical use of this drug in military surgery was a cumbersome process; and Daguerre's box, with a hole in it, is a far cry indeed from the modern military aircraft reconnaissance camera.

c. Fundamental research as defined above is not a priori directed toward military aims and specific results from it cannot be anticipated. Therefore the yield from this type of research can neither be safely included in plans nor can even its direction or impact on warfare be estimated in advance. Yet one statement seems safe. The war potential of a nation, strong in fundamental research is immensely enhanced, not only by the ultimate results of such research itself but also because of the availability of personnel trained in research. In modern wars, characterized by use of an infinite variety of technological processes, a pool of scientists is as important a reserve as are men trained in the use of weapons.

d. Fundamental research has mostly been centered at educational institutions and research foundations. It is dependent upon the free, creative and imaginative mind of scientists. The less it is hampered by restrictions, the more likely this type of research is apt to produce results. Government agencies, including the armed forces, should foster fundamental research, - but they should not attempt to dictate its course. On the other hand, the armed forces should be completely aware of the results of such research, and for this purpose special scientific liaison officers should infiltrate the knowledge gained in research laboratories into the thinking, planning, training and operations of the country's armed services.

4. a. Applied scientific research is more closely related to everyday practical life. It will translate general knowledge into useful applications. It intends to find answers to specific practical problems and questions. The methods of approach are not different from those of fundamental research but, generally, the attention is focussed on achieving specific aims. The time lag between gaining the knowledge and using it for practical purposes is normally much less than in case of fundamental research.

b. A distinction can be made here between scientific and engineering or technological research, less because of any difference in approach but more because of the frequent separation of these functions in institutions devoted to these pursuits. Applied scientific research is frequently carried on in educational institutions and often, under a system of grants, goes hand-in-hand with fundamental research carried on at the same institutions. Technological or engineering research is, to a considerable extent, carried on by industrial establishments. Applied scientific research may frequently be satisfied to find the answer to a problem, independent of whether this answer is immediately



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translatable into an economic process, a marketable product, or a profitable procedure. These latter aims are directly the purpose of most technological research programs.

c. In case of both of these types of applied research the armed forces have a considerable interest to see their own problems solved either in conjunction with similar problems of commercial and industrial enterprises or, where necessary, independently. The main point here is to make the immediate problems known to the research workers, formulate the appropriate questions and furnish sufficient background information to the scientists working on such projects. As far as possible, this type of research should also remain free from direct control by the using or sponsoring agencies. Industrial experience has shown that it is most profitable to leave the research department alone. The motto should be: Give them the problems but don't dictate to them how to find the answers. Many experiences with the current researchwork done by and for the armed forces teaches this, as well as another lesson. The second lesson is the need for two-way liaison between the consumer, i.e. the armed forces, and the producer, i.e. the laboratory. This is a most urgent need at this level of research. The officers formulating the questions or anticipating problems ought to have sufficient scientific training and insight into research procedures so that they can intelligently convey them to the research worker. In turn, the scientist working on this level should understand the military operational procedures that gives rise to the questions and problems so that he can approach them with a realistic attitude. It is quite conceivable that at this level of research, the armed services will maintain their own research facilities for certain phases, essentially in the same way that industry maintains its technological research facilities. This would be necessary for the problems so peculiarly military in character that none of the educational or commercial laboratories have the facilities to conduct this type of research.

5. a. An important corrollary of research is the testing of the results and products of research. Testing is essentially a function that will establish whether a piece of equipment or a procedure satisfies the needs, meets specifications, and can be handled by the personnel available for its use. Testing will follow the research developments and also will be needed to check the manufactured products. In other words, it will normally have both to precede and succeed the production process incase of equipment and material.

b. The testing or proving ground facilities should be under the control of the consumer. He is the only one who can ultimately decide whether the product is satisfactory. On this level imagination is not as important as in the research phase but objective evaluation of the results achieved is essential. The operator has to have the decisive voice in this phase. The practical man - be he pilot, or navigator, or gunner, or engineer - who has to use the equipment and procedures is the central figure in the test phase. He should, of course, understand his own job thoroughly, but he should also be able

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to approach new ideas without bias and prejudice. He should be able to present the results of his tests in a scientific manner so that they can serve as a basis for further development work in the research laboratory.

c. The test and proving ground facilities should be adequate and in themselves realistic. It may be remarked parenthetically that in the past some proving ground facilities, either by virtue of their location or their personnel, did not fulfill this postulate. There necessary this has to be remedied. At times, only the large scale maneuver, or war itself, can act as the proving ground.

6. a. The final phase in the research picture for the armed services is the operational analysis research. This is to be carried out both in the training (maneuver) phase and in the war phase. Its principal functions are the evaluation of results achieved with weapons, equipment, and men in terms of strategical and tactical plans, - and most of all, in the light of enemy opposition. This last point is of vital importance. Many pieces of equipment which worked out quite satisfactory on the proving ground and in training may become obsolete in a short period of time if the opposing side is able to vitiate its offensive or defensive effect by countermeasures. While intelligence may to some extent mitigate such events in case of new enemy weapons, only the war phase will ultimately reveal the total extent of enemy capabilities.

b. The operational research phase has first to determine the actual effectiveness of our own measures and devices. As such the research is evaluating in character. The next objective is the recognition or (in some cases, from past experience) the anticipation of difficulties. This analysis will again result in the formulation of questions and problems that in turn can be referred to the research laboratories for solution. A high degree of scientific skill is required in this analytical phase.

c. In this last stage of military research a very complete integration [illegible] of the scientific analyst into the military operational team is required so that his insight into the problems is absolutely first hand. Where such an integration is achieved the scientist can, on the other hand, serve as a medium through which scientific knowledge gained in the research laboratories can be infiltrated directly into military operations. This function will become particularly necessary during wars, when time is an essential factor and when the slow procedures and channels of peace times are inadequate and detrimental.

7. It is in the interest of the armed forces and necessary for the preparedness of the country that the following postulates be fulfilled for research outside and inside the armed forces:

a. Have strong laboratories in educational and other private research institutions, staffed by the best available men in science, adequately financed for the unhampered pursuit of fundamental research.

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b. Have highly trained scientific liaison officers who can evaluate scientific results obtained in research laboratories and infiltrate their knowledge into military thinking and staff planning.

c. Have adequate research facilities for applied scientific and technological research in private institutions and commercial companies, generally working under contract with the armed forces. Maintain close liaison by acquainting adequately trained officer personnel with laboratory progress and afford the scientists working on military projects complete insight into military problems and procedures. Supplement the private research facilities with laboratories working inside the military organization where private facilities are non-existant.

d. Have proper independent proving ground facilities in the appropriate locations for testing, with realistic approach to the problems.

e. Maintain operational analysis for evaluation of men, materiel, and procedures in training and combat. Have the problems arising in those phases of military activity properly formulated to make them amenable to solution by research.

f. Avoid complicated command and administrative channels in all phases of research activities. Do not place personnel inadequately prepared to understand, evaluate, and use research results in charge of pertinent activities.

8. The question now remains how such an overall research plan can best be incorporated into the existing structure of army organization and civilian research facilities. There is no easy answer available to this question but experiences gained during the current war may help in devising the proper permanent approach to the answer. For the Air Forces, for example, the following scheme might offer such an approach: (see next page)

9. a. The key problem in the whole system is the Scientific Liaison Office. This is an organization that should be created to make the plan work. Its functions are that of an over-all clearing house of scientific and technological information. The chief of this office is also charged with acting as scientific advisor to the Commanding General of the Air Forces. As such it is his responsibility to see to it that research results obtained outside of the Army areapplied to Army planning and problems. He should monitor the scientific heart beat of the nation. At the same time he should coordinate all scientific activities inside the Air Force organization. Such a job can only be effective if there is direct access to the top of the Air Force, where the ultimate decisions of policy are made. In any subordinate echelon the danger of sidetracking the use of scientific research as a military tool will exist.



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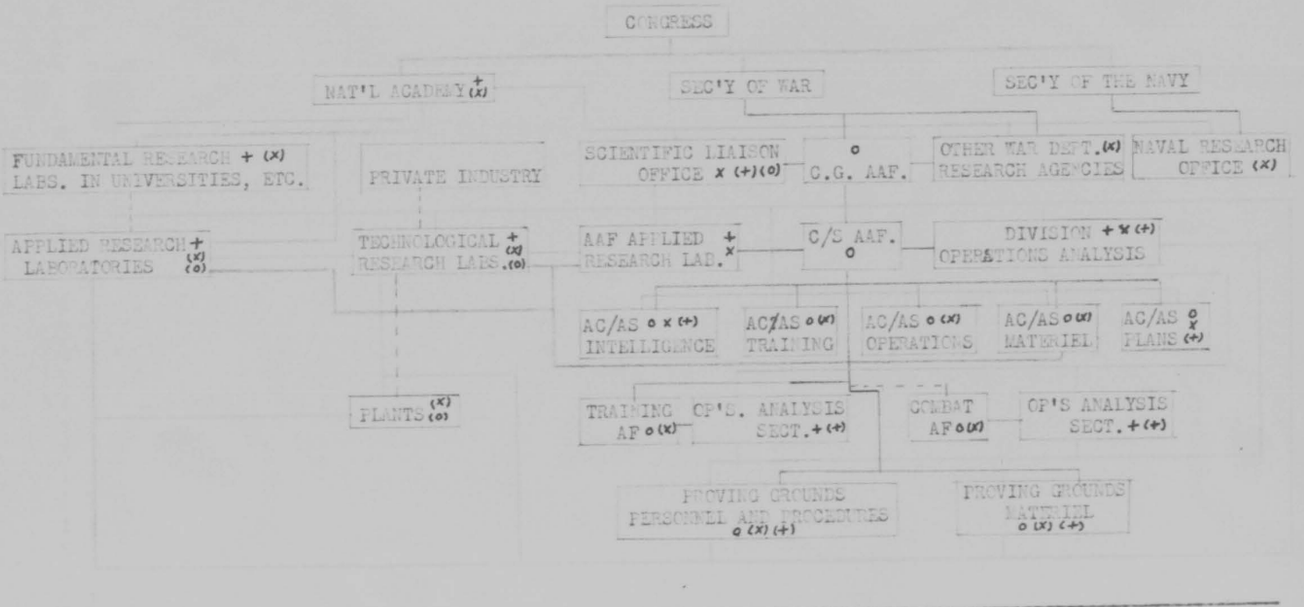


COMMAND CHANNELS
TECH. CONTROL CHANNELS
MONEY CHANNELS
CONTRACT CHANNELS
TWO-WAY INFORMATION CHANNELS

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b. The staff of the Scientific Liaison Office should be composed of officer - scientists. They should be thoroughly familiar with both military operations and scientific research, in fact, they should be trained for such a dual capacity. It will require selection of outstanding men of unusual alertness. Probably only a slow process of development and growth will result in bringing the proper people into those jobs.

c. One of the most important functions of the Scientific Liaison office is to see to it that information from all sources is disseminated to all interested parties. All the information channels shown on the organization chart, which on first sight, look somewhat confusing can be readily taken care of if all available and pertinent information flows into the scientific liaison office. This office should then be charged with making the information available in form of journals, reports, circulars. The policy of distribution should approximate as closely as possible peace-time scientific publication usages with military security restrictions limited to the bare minimum especially as regards scope of distribution. War-time experiences have shown that classified information can safely be given to a great circle of people who will not, on their own, divulge it to unauthorized person. But for the purpose of keeping all concerned in research of military importance completely informed, a liberal attitude on the distribution of information is essential. A sound and balanced policy in this respect can only be developed after some experience with such a scientific liaison office has been gained.

HELMUT E. LANDSBERG
Operations Analyst

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QUOTATIONS PERTINENT TO THE PROBLEM OF RESEARCH FOR THE ARMED FORCES.

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A. Editorial from the New York Times of 11 May 1945:

"When it became apparent that a modern war could not be fought without physicists, chemists and engineers, the Office of Scientific Research and Development was created by executive order. The total cost of carrying out the program of the Office, including obligations still to mature, is $472,994,799 - the largest sum ever spent by any country for war research. All the evidence available indicates that the country got its money's worth. Never was science so effectively mobilized. Now that Germany is beaten, are we to leave research to the Army and Navy alone? The Woodrum Committee answers with a ringing "no." It is all for continuing military research "in appropriate dimensions in time of peace."

If we are to follow the recommendation of the Woodrum Committee, Congress cannot be ignored. It has therefore been suggested that research be provided for in separate appropriations for the Army and Navy. If this were done, requests for appropriations would have to be referred to separate Congressional committees which now deal with the needs of the Army and Navy. No single body could envisage the whole field of war research. Moreover, each branch of the armed services would attempt to secure the largest possible appropriation. The Woodrum Committee, supported by Secretaries Stimson and Forrestal, would turn the whole matter of war research over to the National Academy of Sciences, which would act through a committee of forty, half officers, half civilian scientists, with a civilian as chairman. This governing committee would control scientific research and development innall branches for the armed forces, with the Academy reporting from time to time to the proper committees of the Senate and the House on expenditures, and the president of the Academy paying out funds on vouchers. The procedure seems to us sensible and practical.

There can be no question that our future security depends not only on an adequate Army and Navy but on the equipment of that Army and Navy. With outmoded weapons even the most admirably trained force cannot be truly effective. Research must continue on a scale commensurate with scientific progress. The fact has been so forcefully driven home by experience gained in this war that we cannot backslide into our old easy way of letting the future take care of itself. Representative Woodrum's committee has performed a valuable public service. We hope that its report will impress Congress as deeply as it is bound to impress anyone who is familiar with the achievements of the Office of Scientific Research and Development.



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B. Letter to the Editor of the New York Times by Admiral Furer, dated 12 May 1945

"I have read with interest your editorial on "Military Research" in the May 11 issue of THE TIMES. It is gratifying to note your recognition of the highly important role which scientific research is playing in this war and which it should play to an even greater extent in safeguarding the security of the nation in the future.

I should like to clarify a point which is made in the editorial which may lead to wrong conclusions. Your editorial speaks of turning "the whole matter of war research over to the National Academy of Sciences" and that the Research Board for National Security under the academy "would control scientific research and development in all branches for the armed forces."

LETTER IS QUOTED

The letter which the Secretary of War and the Secretary of the Navy wrote to the president of the National Academy of Sciences requesting the establishment of the Research Board for National Security states, "It shall be the duty of the board to formulate programs of national security, to direct and conduct the scientific study of such problems and to advise the Secretary of War and the Secretary of the Navy on the applications of science to national security. *** The board shall, in no way, relieve the Army or Navy or other governmental agencies of their responsibility for, or authority over, research and development work conducted under their legal cognisance.

The report of the House Select Committee on Post-War Military Policy submitted by Mr. Woodrum and referred to in your editorial of May 11 states with respect to the board under the National Academy of Sciences that "its function will be to exercise over-all control of scientific research and development in support of the armed services." This should be understood to mean that the board will have control of additional or supporting research. This clarification seems to me important because otherwise the impression may be left with the reader that the Army and Navy will be relieved of some of their responsibility for research by the board, or may even discontinue to carry on research themselves. This is far from the fact.

SUPPLEMENT TO SERVICES

Both the Army and the Navy operate and will continue to operate extensive establishments for conducting research. It would be fatal to discontinue this important work or to turn over the control of such work to a board, even though the Army and Navy will be well represented on the board. The important contribution which the Research Board for National Security is expected to make is to augment the work of the services, particularly in those scientific fields having military significance which involve long-term fundamental research and in attacking specific problems which can best be handled by an agency not within either service but which has direct access to the thinking of outstanding scientists in civil life.

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If the board continues to receive the wholehearted support from all sides which it must have, we feel confident that this supplementary arrangement will keep the nation in the forefront of scientific military preparedeness."

C. Excerpt from an Address by Secretary of Commerce, Henry A. Wallace, Before the Institute of World Affairs at the New School for Social Research on 24 May 1945:

"As I think about the fundamentals of our problem, I am convinced that an important contribution can be made through Government by continuous emphasis on fundamental scientific research. This will not be to the disadvantage of any private research institutions. Quite the contrary! I have had the opportunity for the many years of watching the interplay between the fundamental scientific work in agriculture conducted by the Federal and State Governments and the research work conducted by private agricultural institutions. Private agriculture has been immensely helped, not harmed by Government.

I hope to see the day when the scientific work in the Department of Commerce is enormously strengthened. It must be strengthened if in the post-war period American science is not to lose ground to Russian and English science. Every bit of fundamental scientific research sooner or later has its industrial implications, and finally its effect on exports and imports."

D. Excerpt from an Address by George A. Sloan Before the University of Chattanooga Convocation on 4 June 1945:

"Declaring that the war has highlighted the close relationship that should exist between the workers in fundamental science and the technologist who serve industries, Mr. Sloan called attention to the fact that since the war started, virtually all research work has been of an applied nature.

""e have been drawing, "he said, "upon the stored information accumulated through the years in the fields of pure science. Had we not possessed this scientific information and trained personnel at the outbreak of the war, our plight would have been hopeless.

"Fortunately we had such a reservoir to draw upon, but its level had been steadily dropping because of the concentration on emergency application. It will be a major national problem to raise this level after the war and the task will be the most difficult because of the acute shortage of personnel, particularly as a result of the loss of college-trained scientists.

TELLS INDUSTRY TO AID SCIENCE

"When the war permits, industry must, as a matter of statesmanship and self preservation, do everything within its power to stimulate fundamental scientific investigation.

"It would be a great misfortune if the educational institutions, as a result of their experiences during the war, shifted too much attention to applied science rather than fundamental investigation.



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Industries will be coming to the universities to solve specific problems, and government, it is becoming increasingly obvious, will finance applied research on a scale never before known in this country.

"Government and industry will make a serious mistake if they divert too much of our scientific personnel and facilities toward this kind of research, at the expense of fundamental study and creative investigation".

B. Excerpt From a Statement by Secretary of the Navy Forrestal, on Occasion of Creation of Office of Research and Inventions in the Navy Department:

"Wars are fought primarily with weapons which are developed before the fighting began. Experience demonstrates that a nation at war usually does not have time to push through a new line of fundamental research and then apply that research before the outcome of the war is decided. Research requires time. Application of its results requires additional time.

"During a war a nation usually has time only to improve and adapt weapons, the fundamentals of which were evolved during the preceding years of peace. It follows, therefore, that if a nation is to be scientifically prepared, its preparedness must be worked out in peacetime."

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SAVE

HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By Authority of
The Commanding General
Army Air Forces
13 Dec. 44 RLS
Date Initials

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

13 December 1944.

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: On Group Reaction to Air Bombing, with Reference to the So-Called "Breaking Point".

1. On 28 November, Commander Francis Bitter of the Joint Target Group spoke with me about the possibility of evaluating the "breaking point" of Japanese populations under air bombardment. As I understand it, the point would be to estimate the kind and severity of attacks likely to be required to result in disorganization of civil defense mechanisms, on the basis of experience in Britain and in Europe and of views concerning Japanese mass psychology. Interesting as this general problem is, I must point out at once that it lies in a field with which I have had no experience. In the space of a week, at Cambridge, Massachusetts, I have been able to locate certain persons who have lived in Japan and who have been interested in Japanese behavior; and others who have lived and worked in London and elsewhere in England and during the Blitz. The statements to be made are the result of conversations with these people, and of the reading of some relevant published material, and some Intelligence Reports. I doubt if there is anything novel or exhaustive in the remarks I am able to make, but perhaps the persons listed can be of further use.

2. The Strategic Bombing Group has, or rather is in process of forming, a rather large group of psychologists, headed by Dr. Likert, from United States Department of Agriculture, who are about to investigate the effects of air bombardment of Germany on human behavior and morale. Professor Gordon Allport (Department of Psychology, Harvard) informs me that on this topic "little has as yet been done". I have been able to examine a list of questions submitted to representative psychologists as a basis for helping to formulate the broad program of the Psychological Section of the Strategic Bombing Group. In these questions, the viewpoint of discovering a technic for the demoralization of a community to the point that it can no longer really fight fires, repair urban services or do productive industrial work, does not seem to be represented. It may well be, of course, that the work of this Group will provide data for such considerations.

3. The National Research Council has a project for a book on "Psychology and the War", under the editorship of Professor E. G. Boring of Harvard, which I believe is to contain a section dealing with psychological effects of bombing. I was unable to consult with Dr. Boring, as he was absent from Cambridge.

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4. It occurs to me that there must be people in O.S.S. who have given attention to the behavior of crowds in Japan under extreme circumstances. This might be a rich source of information.

5. I am informed that on 15-16 December there is to be a conference, under the auspices (in part, at least) of the Institute of Pacific Relations, to Discuss "Japan after the War". The Research Secretary of I.P.R. is William L. Holland, at 1 East 54th Street, New York, N.Y. Included, is a plan to consider behavioral patterns of the Japanese. The results may contain matters of interest.

6. I understand that, under the auspices of O.S.R.D., Dr. (Major?) H. Murray is to write up the results of an examination of the British and the French experience, from the psychological standpoint.

7. The earliest consideration of the psychological effects of bombing was given by Mira y Lopez, on the basis of observations during the Spanish Civil War (e.g. at Barcelona). The statements are of a rather general character, but stress the absence of violent forms of panic. Brief accounts of Mira's experience have been printed in a large number of articles (see: Occupational Psychology, 1939, vol. 13, 165-177; Brit. Medical Journal, 1939, 1217-1220, etc.). Glover has a useful article on "Air Raids" (on Britain) in the International Journal of Psychoanalysis, 1942/43; and there is Tom Harrison's book (Penguin Series) on Coventry; as well as a number of articles in British Medical Journals. A good brief summary of the situation is given by Mackintosh in his book "The War and Mental Health in England" (Oxford Press, 1944). The chief point is that "more distressing than the terror that flies by night was the disorganization that followed by day, and the anxiety produced by recurring attacks night after night"; "the haunting anticipation rather than the event tends to undermine mental stability". One encounters numerous references to the thought that "a few more nights of it would have produced a real "crack", but the sheer fact is that no "crack" came, Mackintosh gives it as his opinion that the advantage of the British lay in the fact at no moment did they believe that they could be defeated. The thoughts of what might have happened always came later. Particularly in view of the fact that German towns have taken very much heavier punishment, with surely no lack of the thought that defeat might be possible, but without "cracking", the reasonable conclusion is that urban populations cannot be counted upon to "crack" in the psychoneurological sense.

8. This opinion concurs with that expressed by Professor T. North Whitehead, of the Graduate School of Business Administration, Harvard University. Professor Whitehead, a British subject, is an engineer by training and has had considerable experience in the British Army and Navy. In recent years his activities have been in the field of industrial sociology. From October, 1939 to early in 1944, he was attached to the

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British Foreign Office and lived in London during the whole time of the great raids, taking his share of the raid duties. He has given me a very detailed account of what he saw and experienced, including the way in which fire fighting and rescue work was organized. He stresses that there was no panic at any time, because the business of fighting fire bombs and other activity, was altogether too swift and strenuous during a raid. Morale, for practical purposes, does not "crack", and it would be unwise to base calculations on the assumption. that it can be caused to "cave in". What bombing does is to increase the difficulty of living and working. During a raid, only saturation bombing, with a high concentration of bombs per unit area and per unit time, interferes with the work of fighting fire and fire bombs. It is a mistake to use new devices by dribblets at first - they should be used in force from the beginning. It turned out that in the raid work women played a considerable and effective part, and their participation had a good effect on the morale of the men.

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b. In another aspect, the story of the port of Hull was recounted. Originally of some 93,000 inhabitants, with some 35,000 houses, all but 6 percent of its structures was destroyed by air raids; yet, and working only in the daytime (because of blackout) the port continued to function, handling something like four times its peacetime tonnage of freight. The story of the Liverpool locks is much the same. The raids made living and working more difficult, but there was no panic disorganization.

c. Professor Whitehead emphasized the importance of producing social cleavages by bombing (a point which is referred to subsequently), or rather of developing potential cleavages. Thus, to emphasize class feelings, bomb workers' dwelling regions, while (to some extent) sparing upper-class zones. Public cohesive morale in London, and in Britain as a whole, was enormously boosted when the West End and Buckingham Palace "took it".

d. While there was raid work to be done, public morale stayed high; there was a notable sagging of morale when the heavy raids ceased. The advent of the rhobomb to some extent reversed this picture.

9. A Memorandum from Operations Analyst Dr. H. E. Landsberg, describing his experience in England, is appended. Here again the point that activity, organized activity, prevents demoralization in a raid, is clear. The effect of disruption of the order of living in producing asperation and fatigue is evident. This Memorandum also contains notes on the "buzzbomb" effects.

10. The problem of the possible utilization of the physiological effects of bombing has been considered by British analysts, from the standpoint of the "breaking" of resistance among ground troops. The starting point for these calculations was the assumption, made by psychologists, as the result of observations on German and British





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troops under bombardment, that if men are exposed to sufficient strain for a sufficient length of time they can be brought into a state of collapse such that for a period they will be unable to fight effectively. Naturally, the question of what amount of strain is sufficient is not easy to answer, for it will vary with many circumstances. As an example, a guess had been made (by British WD ORS) that 3 to 4 hours duration would be required to accomplish sudden collapse, with slow recovery, if a 25 lb shell were to explode within 40 yards of each man every other minute during 4 hours for troops in slit trenches. The effect of the expected 10 to 20 percent casualties under these particular circumstances is to be thought of as contributary. It has been estimated also (Operations Analysis Section, Thirteenth Air Force, letter of 2 May 1944) that such effects could be improved by a progressively mounting intensity of bombardment for a longer period. The quoted estimate gives some conception of the intensity of the effort required. It is still not clear that recovery from the physiological effects of such a bombardment would be slow; some experienced opinion among Air Force Medical men was that recovery might be quite rapid. Moreover, the reactiveness to the bombardment will not be the same in immobilized troops as in urban populations with fire fighting and rescue work to do. In the absence of cases in which immobilization of civilian groups has been achieved by air bombardment, it can only be said that very high concentrations of missiles on the target would be required; if the destruction of the target is desired anyway, the factor of direct popular reaction need not be separately considered, since the maximum achievable interference with fire fighting and the like will be arrived at anyway.

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11. I have not been able to obtain descriptions of the effects of Japanese bombings of Chinese cities. Certain things are described or implied, in the writings of Ted White, Edgar Snow and other correspondents. It should not be too difficult to obtain information on the behavior of Chinese city populations, and it should be useful for comparative purposes, as perhaps supplying a kind of bridge between the behavior of Western peoples and the psychologically "tighter" Japanese.

12. The question of Japanese civilian reactions to bombing may receive an answer similar to that supplied in Britain and in Germany. On a trip to Cambridge (30 Nov - 8 Dec) I was able to talk with a number of men connected with the School for Overseas Administration who have some basis for opinion on this matter.

13. Professor S. Elisseef, Director of the Harvard-Yenching Institute, lived in Japan for some time, knows the country and the people well. His Doctor's degree was taken at University of Tokyo. He holds that the systematic air raid drills, the general expectation of the coming of air raids, the construction of concrete school buildings used as raid shelters, and of other modern buildings available for use as emergency hospitals, in Tokyo, for example, have done much to prepare the populace. He has never witnessed panic behavior in Japanese





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crowds, even during earthquakes. He believes that the "breaking point" for Japanese is beyond that for Europeans, but that when a "break" comes the effect is more violent and extreme than with Europeans. This holds for the behavior of single individuals, as all observers seem to agree. Japanese crowds are docile, responsive to authority and leadership.

14. In this connection, a recent broadcast by a Japanese journalist at Moscow (which I did not myself hear) is said to have admonished the Japanese people to model their anti-air raid tactics on those of the British; that raids were sure to come heavily; and that their effects could be withstood.

15. Mr. Langdon Warner has lived in Japan and in China; he is a Curator at the Fogg Museum at Harvard, and connected with the School for Overseas Administration. He agrees that Japanese can "crack" under strain, but less easily than Europeans, and that such "cracks" result in berserk rage and "running amok". He points to a feature of Japanese psychology which may be significant here: the connection of docility with moral cowardice; while singularly brave in war, they are "arrant cowards" in matters of civil responsibility. When Japanese have been starving, they have frequently lashed out at rice hoarders and corrupt officials, but never at the social system fundamentally responsible. He points out also that in recent times the system of family and clan loyalties has been to some extent broken down by the army structure, where merit alone meets the test in a time of rigorous war; and by the gathering of the women into city factories, the influence of this trend in affecting the fire fighting and general raid-resisting abilities of a population systematically taught to act rather than to think, might be important.

16. (a) The points already made were reinforced in a long talk with Professor Douglas G. Haring, sociologist, who lived and taught in Japan for something like 20 years. He is now connected with the School for Overseas Administration at Cambridge. The maximum effectiveness of bombing, so far as disruption of activities of civil populations and deterioration of morale is concerned, would probably be achieved if-a) a regular spacing of raids over a given target were to be maintained, coupled with-b) at irregular intervals a "scrambling" of the schedule by a heavier-than-usual raid.

(b) Dr. G. H. Parker, Professor Emeritus at Harvard, spent some time in Japan ten years ago. He also agreed that Japanese groups would be hard to "break" in morale, but that if a "break" could be achieved, the effects might be extreme. Even among well-educated Japanese the studied fatalism, coupled with at least affected absence of personal concern over catastrophic loss of one's house and the like must be taken into account. To what extent such a factor is significant with the working-class is not clear.

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17. (a) Professor Lauriston Ward, Associate Director of the School for Overseas Administration at Harvard, Mr. Langdon Warner, and Dr. Haring of that organization, have given me the names of several individuals, doubtless already used for their special knowledge but possibly not queried on this specific matter. I have not yet had opportunity to consult with them myself. They are:

Mr. Arthur C. Lumley,
(formerly with Allied Chemical Interests,
Far Eastern Division, Kobe)
Now with School of Overseas Administration,
Harvard University.

Professor Bibber,
Dean, Engineering School, Union College,
Schenectady, N.Y.
(Went to Japan immediately after 1923 'quake)

Mrs. Miriam Beard Vagts
(Daughter of Charles Beard, Historian;
living with the family, in Connecticut.
Was in Tokyo in 1923)

Major Sherwood Moran, U.S.M.C.
(Formerly in social center work in Japan,
for about 20 years; said to know the factory
workers; now occupied with P/W interrogation)

Miss Anabel Paley,
Graduate School, Yale University
(Lived in Japan 30 years)

Dr. J. Spencer Kennard,
544 West 157th Street, New York, N.Y.
(Spent about 10 years in Japan; wide interests)

D. C. Holden,
Palo Alto, California
(Important student of Shinto)

"Lt. Col. Robert S. Spencer, G-2"
(I find a Lt. Col. W. W. Spencer, Int., in
the list) Said to be especially well informed
on Japanese reactions)

(b) It may be suggested that a search through Japanese literature, if it has not been made already, might reveal a good deal in descriptions of popular conduct during catastrophic incidents. It could also tell something of how such behavior is regarded, by winters at least. The factor of repetition, as with air raids, would, of course, not be represented.



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18. (a) The Morale of the Japanese people is determined by, in fact is made up of the emotional drives and appetences built as reaction to the conditions of their life. The structure of this morale involves, as all observers seem to agree, a fluctuating conflict between insecurity and frustration. This has been discussed at some length in a British War office paper on Japanese Morale, by Major J. Kelnar, August 1944 (Army Air Forces Intelligence Library; Secret K-86525, Dec 7, 1944). According to psychological interpretation, the thing which is typical of the Japanese is the sadism-masochism duality which so many aspects of their behavior illustrate. Among the mass of the people the submissive facet of this bundle of contrary tendencies is more prominent. Burdens imposed by fate are just borne. "Fatalism" is merely a name for readiness to accept the power that oppresses as inevitable. The strength of this factor is great, since it is grounded in the whole social and political mythology. The breaking of morale at large would require the enlivening of the very largely suppressed hostilities to the leaders, so that it would be felt that the "will to fight" is not any longer a satisfaction of social needs, no remedy for the suppressed hostilities.

(b) With reference to the effects of air bombardment, this can probably be safely said:

(1) The strikes, to break morale, must be very heavy, continuous, with mounting concentration in time and space and with irregularly distributed heaviest raids interspersed.

(2) To emphasize potential social cleavages, bomb workers' living quarters, not higher class dwelling regions.

(3) There is no reason to suppose that Japanese civilian morale will fail to stand up under bombing as severe as that visited upon Britain or upon Germany. There is no evidence that the sheer morale of an urban population can be caused to "crack" by air bombardment. This might be modified by conditions of extreme conflagration, in Japan, but thus far, in Europe no sign of panic or of enduring physical immobilization due to air bombardment has been described. It would be unwise to assume that they will be produced in Japan, or to base expectations on the assumption that they will be produced.

(4) A point not explored in this memorandum, but which is of first importance, concerns the general effect of regular bombing upon the state of cumulative fatigue, as affecting the vigor of air raid work; this is highly significant; the increase of

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respiratory diseases, and of digestive disturbances may also be looked for, and will also be a part of the slow process of deterioration; but these will not necessarily induce sudden neuro-psychological collapse of any widespread character.

(5) To the extent that it is desired to overwhelm a population, to "break" its ability and possibly its will to fight fires, for example, it is of first importance to make large scale use of new technics and new weapons. Repeated small scale use of them merely provides familiarity and increases the ability to deal with them more effectively.

W. J. CROZIER
Operations Analyst

1 Incl

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

28 November 1944

SUBJECT: Psychological Effects of Bombing

TO : Dr. W. J. Crozier, Operations Analyst.

1. Complying with your request, I am giving you below some impressions I got during my stay in UK on the psychology of bombing. I wish to emphasize that this comprises only my own limited personal experiences during a two months stay last Winter and a three months stay last Summer. How far one can generalize such personal observations, I don't know.

2. First, I would like to cover ordinary air raids of which I experienced about 20 or 25, most of them of the sneak-in and run-out variety, but four or five were attacks by from 60-to 100 planes. None of them were really heavy. All of them were during hours of darkness.

a. During the first two or three raids, curiosity seems to be the main impulse. People want to watch the "show". Americans seem to have that bad habit particularly. I recall an occasion when an air raid was going on and almost all the officers at the time in the Officer's Club, about sixty of them, went to the front door, standing in a clump, looking at the "fireworks". Of course, this was decidedly not the thing to do. One bomb could have killed all of them. The curiosity is lost after the first flak shrapnel falls around you and you are likely to take cover.

b. The ordinary raid does not get particularly on your nerves because you know it will "soon" be over. At least, in the ones I experienced, they rarely lasted over an hour. Besides you knew about on what days the Germans came over and sort of got set for the occasion. Most of them last Winter came fairly early and after it was all over you went to bed and felt quite safe for the remainder of the night.

c. More annoying were raids in the hours of first sleep (2300-0200). You woke up, were a little sleepy at first. Noise from ack-ack kept you awake and finally you woke up completely and in many cases, even after it was over, did not fall asleep again for quite a while. (The cold in the rooms at that time of the day may have had something to do with it). Even more annoying were double raids. One earlier in the night, and one perhaps an hour or two after the end of the first. You expected it to be over after the first. You got comfortable and settled, and then you were rudely shaken out of a complacent and relaxed state of mind.

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d. Sticking or sitting out a raid by yourself was more nerve wracking than being in company with a lively conversation going on. People with whom I was billeted were quite callous to raids and often didn't bother to get up or take shelter--until they had a hit in their immediate vicinity. After that they usually got more apprehensive and took shelter for several subsequent occasions.

e. I am reasonably sure that the night raids last Winter had a measurable effect on people's health. To get up in the middle of the night, get only dressed in fragmentary form, together with a low state of nutrition and crowding in poorly ventilated shelters undoubtedly helped to spread influenza.

3. Second, I may give you some of my experiences during the bombardment of Southern England by robot bombs. I had about five weeks during the first, and worst, period of that. On the whole, I can say that my own reaction was that of being a great deal more terrified by the "buzzbombs" than by a regular air raid.

a. First it seems to me that a new experience for which one is not conditioned is more devastating than something you have come to expect. Next was the sustained continuity of the attacks during the first couple of weeks. Psychologically, you felt worse after they stopped the anti-aircraft barrage (about on the fourth day of the attack). While the guns were booming, even though the noise was infernal, you felt at least that something was done against them but later when silence prevailed and you could clearly hear the bombs coming over, cutting their motor and explode you felt rather helpless. This in spite of the fact that the defense measures adopted later were undoubtedly more effective than the mass shooting in the beginning. As a matter of fact, I had the impression if they had only shot some firecrackers into the air it would have been an element of reassurance to the people under bombardment that "something" was being done.

b. Personally, most annoying and irritating about the buzzbombs were the way they upset your balance by interfering with well established daily routine. It seems that barrages of them came over at planned times.

(1) The milk run at 0600-0800 or 0900, the time one got up, shaved, went to work and ate breakfast. The interference with this routine, even if you stuck with it was bad because you were with one foot at the door to take shelter if one of the "doodlebugs" came close.

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(2) The lunch delivery, 1200-1300, probably had some effect on your digestion. I once noticed a young lieutenant in the mess who had finished his lunch except his dessert, run out of the mess without eating his pie because just at that time an inimminent danger warning of an approaching buzzbomb came over the loud speaker. He rather took shelter than eat his food.

(3) The tea hour "cookies" came from 1700 to 1900. It interfered with people coming home from the jobs.

(4) The night cap, at 2200-2400 made you stay up longer than usual. You disliked to take your bath because you didn't want to get caught wet and naked. Anyone who has heard the 'phone ringing in an otherwise empty house while he is bathing has had a somewhat comparable if not so terrifying experience.

c. Again, night raids were, on the whole more terrifying than day attacks. One felt more helpless lying around alone, than in day time with others around. But even in day time in shelters with jokes going around, apprehensiveness was noted, expressed in the large number of cigarettes being lighted and half or quarter smoked under such conditions.

d. One case of mass psychological effect occurred during my experience. One day during lunch hour with about 150 officers in the mess hall, a buzzbomb cut out in our vicinity. Nobody seemed much perturbed but one man hit the floor and a second afterwards everybody else was down.

4. The policy of the British Government to keep completely quiet about the robots for the first two or three weeks was, in my opinion, psychologically a mistake:

(1) People were very apprehensive, whether anything was being done for their protection. They felt the "boys" upstairs were just as helpless, which actually was not the case.

(2) The complete silence about the existence of the buzzbombs before their advent, although good intelligence on them was available, left people completely unprepared mentally for the event, in spite of occasional dark hints in the press that there might be something to the German propaganda claims of effective V-weapons.

(3) The silence of the government on facts and figures concerning the bombs, allegedly to hide information from the enemy, led to a large and rapid circulation of the most exaggerated rumors. These seemed just



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about trustworthy to the people because some rather startling damages occurred in most environments. So if a bomb knocked out six houses in one section, people would believe that elsewhere in another section "much more" damage had been done, whole blocks wiped out, hundreds killed, etc. I think it caused a surprise and relief to everybody when Mr. Churchill announced after three weeks of buzzbombing that only one fatality per bomb had occurred. If such figures had been announced right from the very start, the good psychological effect would have been tremendous, and might have outweighed the security reasons for with-holding the information. I believe, if Goebbels had started the rumors, he couldn't have done a better job. In areas not under bombardment, these rumors were even more exaggerated.

f. Quite disconcerting were unexpected bombardments. I recall the case when I wanted to get a good night's rest after several rather hectic nights and went to a post thirty miles from my regular station and had a bomb landing there, where none had been before and none were expected.

g. Equally disturbing were enemy propaganda broadcasts by Lord Haw-Haw, who one afternoon announced that a certain U. S. Headquarters would get a packet that night, and lo and behold, actually a few bombs hit the vicinity of that post. This may have been entirely fortuitous and due to the normal statistical distribution of these bombs but it had a considerable psychological effect because people started to believe that the aiming of the bombs was by far more accurate than they had been led to believe or than they actually were.

5. Least apprehensive among all people, in both air raids and buzzbombs raids, although actually more exposed than others, were people engaged in defense activities like military defense personnel, fire watchers, air raid wardens, etc. They had a job to do and their duties kept their minds occupied.

HELMUT E. LANDSBERG
Operations Analyst

HEL:evd

P. S. Incidentally, small children, dogs and cats got "conditioned" to alerts. As soon as the air raid sirens went off, they ran straight for the next shelter.

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

11 October 1944

NOTE FOR THE INFORMATION OF:
CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH, AF

Subject: Removal of Absolute Altimeter SCR 718-A from B-29

1. In visiting OAS of Second Air Force I understand that there is a persistent rumor floating around to the effect that the absolute altimeter is to be removed from the B-29.

2. It is contended that the present radar equipment can serve satisfactorily and function as absolute altimeter.

3. If this rumor is correct consideration should, however, be given to the use of the absolute altimeter in navigation. Colonel Combs expressed when I was here in August considerable interest in the so-called "D method" of navigation developed by Mr. Bellamy and extensively used by contract carriers over the North Atlantic. At that time I prepared a memorandum for Colonel Combs outlining some of the advantages of this system of navigation.

4. This system of navigation is impossible without the radio-altimeter. It is a very important aid for navigation when flying blind for a considerable distance. Such conditions may frequently be encountered by B-29's flying over great distances.

5. The accuracy desired for the "D-Method" of navigation is about 10 feet for the absolute altitude. This can be attained by the current model of the absolute altimeter if readings are carefully made according to tried methods. The radar equipment now in use in the B-29, according to radar experts cannot be much improved in that respect for a considerable period of time. It will only allow readings of altitude accurate to 250 feet.

6. This lack of accuracy will completely vitiate any navigational advantage that might be obtained from the radio-altimeter. This matter should be given careful consideration before a final decision on the elimination of the absolute altimeter from the B-29 is made. At any rate, the saving in weight is not sufficient to warrant gambling wasting of gasoline due to errors in navigation.

H. E. LANDSBERG
Special Consultant

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HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25. D. C.

17 Jan 45

MEMORANDUM FOR DR. ROBERT L. STEARN, Chief
Operations Analysis Division,
Twentieth Air Force

Subject : Computer for use in connections with SCR-718 Altimeter

1. Captain Forsythe, of the Weather Division(Research Executive Branch) informed/me that a requirement had been set up through them to procure a computer that can be used in connection with drift determinations by means of the SCR-718 absolute altimeter. The problem is now in the hands of M & S for development.

2. A circular slide rule that will enable to make the necessary computations rapidly, has been designed by Dr. Burke, Computing Section, ATSC Engineering Division, Instrument and Navigation Branch, Wright Field, The Weather Division has requested routinely, that some test models be provided for tests by the AAF Board. As soon as these tests are completed, production can be started. At present, the matter is still mostly on paper.

3. If the absolute altimeter goes back on the B-29s, the computer will be mighty handy to have and at that time it would be appropriate for us to see that the matter of testing and producing the computers is expedited.

4. In the meantime, the Weather Division will start another R & R to set forth the scientific reasons for putting the SCR-718 back on VLR aircraft. Captain Forsythe will send a copy of this R & R to us for information.

5. Upon my suggestion, Captain Forsythe has compiled some tables that can be used in lieu of the computer as a makeshift aid. If my trip materializes, I can take one of these tables along for field personnel. Colonel Tieman also plans to take a set with hom.

6. There is a Weather Officer with the 3rd Photo Reconnaissance Squadron who is thoroughly familiar with the use of the SCR-718 for navigational and meteorological purposes. If necessary, he can set up a short informal course for XXI Bomber Command navigators in the field to familiarize and train them in the use of equipment and methods.

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HELMUT E. LANDSBERG
Operations Analyst

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21 February 1945.

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION.

Subject: Tests On Miscellaneous Equipment To Be Conducted By AAF Board.

1. Various developments in which the Twentieth Air Force has expressed interest at earlier dates are now before the AAF Board for tests. These are:

a. Use of the absolute altimeters SCR-718 A and SCR-718 C for drift determination.

b. Computer and tables to be used in connection with drift determinations with altimeters SCR-718 A and SCR-718 C.

c. Dropable radio-sonde developed at instrument research laboratory of Department of Meteorology at the University of Chicago.

2. According to Major Petersen, OC&R, Weather Division, all these projects are set up with an A-1 priority for board tests. I took the matter up with Captain Waugh, Board Project Officer in Hq. AAF, and was told that setting up of a priority etc. is not necessarily the last step in seeing that speedy action is taken and that the reports really contain the information desired. If the directives are too general, the project officer not knowing all the background leading to the request to the Board for tests, will conduct an exhaustive, comprehensive, expensive study, which may take months and a bulky report will be the result. This is being done in order to make sure that all aspects of the particular development are covered and that the directive is being covered as completely as possible. However, in many cases a quick answer is desired to be able to get further action. The thing to do is to keep in close contact with the project officer and visit personally the Board when the tests are under way to get the most vital information in a hurry; have this consolidated into a quick advance report and let the full dress story wait for a later time.

3. a. What the Twentieth Air Force is mostly interested in now is the computer for the SCR-718. Some of the airplanes in the field are equipped with these altimeters and others will be soon. In order to calculate drifts this computer will be very helpful. A paper model has been delivered for testing. This is a matter that could be done in a couple of weeks.



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b. Equally important are the tests on the dropable radio-sonde. Dr. Ference and his crew have a working model ready for tests. During Dr. Ference's visit in Washington during the last few days, I have shown him all the data collected by the Navy in connection with their dropable radio-sonic buoy. There are certain mass production items on this equipment that can be completely lifted from this Navy development and bodily incorporated into the dropable radio-sonde, such as the parachute and the antenna arrangement.

4. It would seem desirable to have a letter sent from the Twentieth Air Force to the President of the AAF Board expressing the interest in the tests on the above named items, so that speedy action is assured. A draft for such a letter is attached.

HEL:evd

HELMUT E. LANDSBERG,
Operations Analyst,
OAD, Twentieth Air Force.

1 Incl - Draft Ltr to President AAF Board.

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22 May 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION, TWENTIETH AIR FORCE.

Subject: Instrument Development Program at the University of Chicago

1. On my recent trip to Chanute Field, I took occasion to further check into the status of instrument development at the University of Chicago. I had discussions there with Dr. Rossby, Dr. Ference and Lt. Scoats.

2. The whole administrative status of this development program is not much better channalized than it was. Conferences have been held with representatives of ATSC at Wright Field and with the Signal Ground Agency in Spring Lake, New Jersey. These agencies have finally become interested in the advanced designs proposed by the group at the University of Chicago and contracts for several pieces of the equipment have been let.

3. a. The problem of the turbulence recorder can be considered as closed since twenty have been ordered by ATSC for further testing and probable procurement.

b. The dew point recorder which is the most satisfactory piece of equipment for measuring humidities at low temperatures also has been ordered in several units by both ATSC and the Signal Ground Agency, and is on its way to find entrance into the testing and reconnaissance program of the army.

c. The sonic temperature indicator promises to enable us to measure temperatures with a great degree of reliabilitiy in fast high flying airplanes, is especially being developed with a great deal of vigor and results should be available shortly. It can also be used to construct a more satisfactory air speed indicator than the current models and Wright Field has asked the people at the University of Chicago to submit a proposal for such a development as soon as possible.

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d. The droppable radio-sonde is still being rushed and I saw three models which have recently been constructed at the University and which should be ready for further field testing shortly. I think that their model is superior for all-round purposes to the current Signal Corps equipment which still has a number of weaknesses that are being worked on a Spring Lake.

4. While it will reqire considerable effort and slow persistent work on the part of all persons interested, I believe that at lesst one gain has been made, in that these developments are now brought into the proper Army channels and that the brain power of the University of Chicago group can be brought to bear effectively upon the problems involved.

HELMUT E. LANTSBERG
Operations Analyst

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HEADQUARTERS, TWENTIETH AIR FORCE
Office of the Commanding General
Washington, D.C.

11 April 1945.

NOTE FOR DR. ROBERT L. STEARNS, CHIEF, OPERATIONS ANALYSIS DIVISION.

Subject: Drift Observations From B-29's.

1. The memorandum of Mr. Bellamy, submitted to us through Dr. Rossby, was discussed informally with a number of individuals and the following lines of action are contemplated.

a. Colonel Yates will take steps to investigate the usefulness of the sonic thermomenter devebped by Mr. Suomi, to see if it can replace advantageously the present thermometer models.

b. Regarding the training of navigators, I had taken opportunity to talk to Mr. Evan Collins of OAS, Second Air Force. Dr. Rossby informed me yesterday that Mr. Collins has requested the temporary services of Mr. Bellamy at the Second Air Force to improve their training along the lines indicated.

c. As concerns maintenance of flight instruments I have talked to Mr. Mc Laren and he thinks that remedial action can be taken in the field. I will write him a memorandum setting forth the facts and he will try to infiltrate some of the points into the field maintenance activities.

2. Certain entirely new lines of development are needed. So far, new eq uipment and procedures have made the job of the navigators more complicated, instead of easier. It is quite evident that the navigators cannot make use of all their facilities because they have not time to familiarize themselves with all the equipment. They also are hard pressed on long-range missions to perform all their duties, they have no chance to relax a minute. I t would therefore seem that equipment has to be devised that will do the job for them. For example, in the D-method of navigation readings have to be taken at frequent intervals of absolute altimeter and pressure altimeter. From these readings the pressure gradients and drifts have to be calculated. Not only does this lead to manifold errors but, in many cases, the effort needed will deter the navigators to take full advantages of this method. It should be seriously considered to make an instrument that will directly combined pressure and absolute altimeter and read directly the values of "D". According to competent radio-engineers this can be done. I have suggested this to Major Wexler, Research Executive, Weather Division, who is willing to cooperate in setting up a military requirement for such equipment. It seems, however, best to first obtain from radio-engineers, such as Mr. Bennett or Mr. Harrison, a preliminary design so that a sound development plan can be set up. ARL at Wright Field, the Kolsman people, manufacturing the pressure altimeter, and RCA, manufacturing the absolute altimeter may have to be brought together to get sufficient basic information for setting up a sound military requirement regarding capabilities etc. This matter will be pursued further.

H. E. LANDSBERG
Operations Analyst

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Subject: Bomb Release

To; Headquarters Twentieth Air Force 1 May 1945

From: A-4 Twentieth Air Force (M & S) Comment No, 2
Major Gurney/eph/74945

1. Reference is made to Memorandum, dated 4 April 1945, prepared by Dr. Glen D. Gillett, Operation Analyst of the 20th Air Fir Force

2. The subject item has been tested by Air Technical Service Command. Preliminary information indicated that the article is not satisfactory for use by the Army Air Forces.

3. It has been found that the bomb-carrying hook operates on the toggle principle, which, when in the closed position, is past dead center of the pivot point. The principle involved thereby requires the hook to lift the weight suspended thereon before the hook reachesthe release position. This condition must necessarily occur whetere release is accomplished by the powder squib, electrical solenoid or manual lever, Such an arrangement is definitely considered bad; in fact, is one of the reasons which led to the replacement of the B-10 bomb shackle, even though the condition was not as pronounced in the B-10 as it is in the model submitted by Dr. Gillett.

4. Trial drops were made with the model and at least one hang-up occured. Release therefore failed. From the a ove findings, it can be assumed that failures could be expected should this type of bomb release be used operationally .especially if the sway braces were not very carefully adjusted. If pressure is caused to bear on the bomb by several of the sway braces when adjusting them, the weight thereby imposed practically prohibits satisfactory operation of the hook.

5. The above information was obtained by telephone from the Engineering Division, Air Technical Service Command, sho has advised this office that written confirmation and model will be furnished not later that 9 May 1945.

/s/ H. G. GURNEY, Major, A.C.
For SOL A. ROSENBLATT
Colonel, Air Corps
Assistant A-4, Twentieth Air Force
Office AC/AS, Materiel & Services

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Subject ; Bomb Release

To ; Asst. C/S, A-4, Twentieth Air Force — 5 April 1945

From : Headquarters Twentieth Air Force — Comment No. 1
LVB/pal/6157

1. Enclosed is model bomb release with memorandum made up by Dr. Gillett of the Twentieth Air Force Operations Analysis section.

2. It is requested that the merit of this model bomb release be checked and a report made to this office.

WM. P. FISHER
Colonel, Air Corps
Deputy Chief of Staff

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HEADQUARTERS, TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D.C.

4 April 1945

MEMORANDUM FOR DR. ROBERT L. STEARNS, CHIEF OPERATIONS ANALYSIS DIVISION
TWENTIETH AIR FORCE

Subject: Bomb-Hook and Latch Release

1. As a result of informal reports of a need in the armed services for an electrically fired squib operated bomb-release, a design was worked out and a model built of such a device.

2. In this design the bomb-hook is pivoted and prevented from turning, before release is desired, by a toggle linkage set a shade beyond dead center.

3. The terminal member of the toggle linkage is made integral with an angular piston, The electrically fired squib fires into the space enclosed by the angular piston.

4. Hence, the pressure generated by the explosion of the squib at the instant of release, rotates the terminal member of the toggle linkage past dead center and actually pulls the bomb-hook into rotation and from under the bomb supporting cable or fastening.

5. The length of the various links in the toggle system are proportioned so that the kinetic energy, deveoped in the terminal and intermediate links, by the squib explosion in the angular piston chamber, is entirely transferred to the rotating hook member by mid cycle to obtain maximum speed of rotation of the hook in releasing the bomb.

6. After the bomb-hook has rotated sufficiently to release the bomb the kinetic energy of the hook is again transferred through the linkage to the terminal member and its direction of rotation reversed so that the angular piston is used as an air check to decelerate the entire system without undue shock and strain.

7. The net result of this design is believed to be a bomb-hook which can be electrically operated by the firing of the squib and which is not only completely positive in its release but also of a design that can be made sufficiently strong to carry, on a limited number of hooks, a bomb of any size now contemplated.

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8. This bomb release can also be arranged without any change in the basic design for spring operation with release by an electrically operated solenoid as well as a supplementary emergency mechanical release if desired.

GLENN D. GILLETT
Operations Analyst
Twentieth Air Force

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SUBJECT: Possible Improvement in Flak Suits — 2 July 45

TO : Headquarters, Twentieth Air Force
Deputy Chief of Staff, Training, Maintenance & Equipment — Comment No. 1

FROM : AC/AS, M&S Assistant A-4, Twentieth Air Force — WHO/eph/74945

1. Reference is made to R&R from your office dated 5 April 1945, subject as above, which inclosed a memorandum dated 3 April 1945 from the Operations Analyst, Twentieth Air Force, relative to the possible use of wire mesh in body armor. Reference is further made to Comment No. 2 from this office dated 2 June 1945.

2. Air Technical Service Command has submitted the following comments relative to the proposed suggestion:

a. It is the opinion of the Aluminum Company of America, which was contacted to ascertain the possibility of making a high tenacity duraluminum wire, that such wire can be manufactured providing it is heat treated.

b. Steel wire mesh embodied in armor has been tested and found inferior to overlapping 24 ST dural which is now being used.

3. The Office, Chief of Ordnance, has advised that that office has had various types of wire mesh under investigation and test ever since a requirement was established for body armor in this war; and to date sufficiently promising results have not been obtained to warrant testing for qualification under the specification now being used for such materials by the Army Air Forces.

4. Since subject material thus far tested has been found to be far below the ballistic requirements of he approved specification, it appears that the use of aluminum plates in Nylon flak suits for such purposes is much more feasible at the present time.

SOL A. ROSENBLATT
Colonel, Air Corps
Assistant A-4, Twentieth Air Force
Office, AC/AS, Materiel & Services

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**Possible Improvement in Flak Suits**

to Asst. C/S, A-4, Twentieth Air Force — 5 April

From Chief of Staff, Twentieth Air Force — Comment No. 1
FAL/pal/74730

This Headquarters believes that the attached memorandum contains considerable merit. It is desired that the memorandum be channeled into a proper agency whereby tests can be conducted to determine the practicability of the information contained.

W. P. FISHER
Colonel, Air Corps
Deputy Chief of Staff

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2 [illegible] Air Force

Miscellaneous Reports

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TO THE ARCHIVES
OF THE AAF
HISTORICAL SECTION

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BY AUTHORITY OF THE COMMANDING GENERAL, ARMY AIR FORCES:

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HEADQUARTERS TWENTIETH AIR FORCE
Operations Analysis Section
APO 234, c/o Postmaster
San Francisco, California

SECRET
Auth: CG 20th AF
Init: E.G.B.
Date: 7/20/45

20 July 1945.

BY: Lt. Col. T.F. O'Keefe

MEMORANDUM TO STAFF MINE WARFARE OFFICER.

DATE: 11 June 1945

SUBJECT: Estimate of Relative Effectiveness of Bombing a Ship Anchorage and Mining.

1. Only the bombing phase of the problem is discussed in this note.

2. A typical Japanese harbor containing a concentration of merchant ships is about 5500 feet square. If a ship presents an area of 10000 square feet what proportion of the ships in the harbor would be expected to receive hits when a formation of 10 A/C aims a pattern of 1000 bombs at the harbor? The pattern dimensions were taken to be 2000 x 4000 feet and the mean radial error of the pattern center to be 1100 feet.

3. The problem is solved by imagining the harbor divided into subsections equal in area to 10000 square feet and finding the expected proportion of subsections hit. On the assumption that the ships are equally likely to be anywhere in the harbor this is also the expected proportion of ships hit.

4. a. The expected proportion is .177, or about 1 in 6 ships, for the conditions assumed in 2, above.

b. If each A/C carries 50 bombs instead of 100 the proportion drops to .115 or about 1 in 9 ships.

c. If each A/C carries 150 bombs the proportion is .210 or about 1 in 5. (In all three cases pattern dimensions assumed are the same and no allowance has been made for gross errors).

Erich L. Lehmann
ERICH L. LEHMANN,
Operations Analyst.

William J. Youden
WILLIAM J. YOUDEN,
Operations Analyst.

APPROVED:
LeRoy A. Brothers
LEROY A. BROTHERS,
Chief,
Operations Analysis Section

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HEADQUARTERS TWENTIETH AIR FORCE
Operations Analysis Section
APO 234

31 July 1945

MEMORANDUM TO AIR INTELLIGENCE, A-2, USASTAF, ATTN: MAJOR SAMUEL COCHRAN.

SUBJECT: Attack of Covered Revetments.

1. The primary object of any attack of covered revetments must most certainly be the destruction of the aircraft within the revetments and not the destruction of the revetment itself. A program of attack having as its primary aim the destruction of the revetments would entail an expenditure of effort out of all proportion to the damage inflicted on the enemy.

2. Fighter attack against these covered revetments can best be carried out by strafing and by the use of rockets (HVAR's). Both the rockets and the machine guns can be fired on the same pass, particularly if the "Wing Line" method of firing is employed (see Air Forces Manual No. 64, 1 May 1945). Such attacks must be carried out against the front or open side of the revetment since these weapons will not damage the plane within the revetment when fired from any other quarter. The HVAR can be fired either "instantaneous", using the nose fuze MK 149, or "delay", using the Base Fuze MK 159 Mod 0, both of which fuzes come as standard issue with the 5.0" HVAR. Against revetments having doors covering the opening the rockets must be fired "delay"; in all cases where the revetments have no frontal covering the rockets must be fired "instantaneous"; the pilot can make this selection at the last moment before firing.

3. Estimates have been made, and are tabulated below, of the number of passes necessary to obtain, on the average, one hit within each of the revetments when attacking it from the front. In other words, half the time the tabulated value will be a sufficient number of passes to obtain one hit. It is assumed that the firing range is 500 yards and that two rockets are fired per pass. These computations have been carried out for three values of dispersion (50% circle), namely, 9 mils, 13 mils and 17½ mils. A dispersion circle of 9 mils represents very excellent firing. Thirteen (13) mils dispersions should be obtained by a pilot who has had adequate training. It is probable that the accuracy being achieved in combat approximates the 17½ mils figure, especially if the "Wing Line" method of firing is not being employed.

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Number of Passes for 50% Chance of One Hit

Firing Range - 500 Yards

| Type of Revetment | Dispersion 9 Mils | 13 Mils | 17½ Mils |
|---|---|---|---|
| 1 | 1 | 2 | 3 |
| 2a | 2 | 4 | 6 |
| 2b | 1 | 2 | 3 |
| 3 | 2 | 4 | 7 |
| 4 | 1 | 1 | 2 |
| 5 | 2 | 3 | 5 |
| 6 | 1 | 2 | 3 |

4. It may readily be seen from the above table that great savings in sortie effort can be made through proper and adequate training of the pilots in rocket firing; thus, excellent firing will result in a threefold decrease in effort over average operational firing. This aspect of the use of rockets cannot be emphasized too much.

5. For level bombing of these revetments with heavy or very heavy bombers from medium or high altitude, it is probable that the 100 lb. G.P. bomb, multiple-suspended, is the most effective weapon. It should be fuzed non-delay tail (no nose fuze with multiple-suspension).

/s/ Norman C. Dahl
/t/ NORMAN C. DAHL,
Operations Analyst.

/s/ LEROY A. BROTHERS,
Chief, Operations Analysis Section.



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11. PRELIMINARY CLAIMS AGAINST ENEMY AIRCRAFT: Following are details of encounters on preliminary claims of 5 destroyed, 4 probably destroyed and 12 damaged.

TABLE NO. 6 - DETAILS OF COMBAT - PRELIMINARY CLAIMS

| Enemy A/C | Claim | No. of B-29's in Formation | Direction and Level of Approach | B-29's Opened Fire (Yards) | Distance E/A Broke Away or Disintegrated (Yards) |
|---|---|---|---|---|---|
| Oscar | Destroyed | 3 | 3 low | 450 | 400 |
| Tojo | " | 3 | 3 low | 600 | 400 |
| Tony | " | 5 | 5 low | 20 | 20 |
| Tojo | " | 5 | 3 high | 500 | 300 |
| Tojo | " | 5 | 6 low | 1000 | 300 |
| Nick | Prob Dest | 3 | 7 low | 900 | 800 |
| Tojo | " " | 3 | 3 low | 600 | 400 |
| Zeke 32 | " " | 5 | 7 low | 1000 | 600 |
| S/E | " " | 5 | 4 low | 1000 | 600 |
| Zeke 32 | Damaged | 9 | 1 level | 1000 | 1000 |
| Tony | " | 10 | 11 level | 800 | 500 |
| Tony | " | 2 | 8 low | 1000 | 1000 |
| Tojo | " | 9 | 10 high | 508 | 50 |
| Tojo | " | 3 | 7 low | 900 | 800 |
| Tojo | " | 3 | 8 low | 1000 | 500 |
| Tojo | " | 3 | 11 low | 20 | 20 |
| Tojo | " | 3 | 4 low | 300 | 300 |
| Tony | " | 5 | 5 low | 800 | 20 |
| Zeke 32 | " | 5 | 4 low | 800 | 30 |
| Tojo | " | 5 | 3 low | 500 | 500 |
| Tojo | " | 5 | 5 low | 600 | 600 |

12. NEW AIRCRAFT AND ARMAMENT

A. No new aircraft were reported. The new Japanese Navy Fighter Jack 11 which has been previously encountered over Omura was not reported on Mission No. 22.

B. One B-29 reported that a Tojo seemed to have guns firing from the extreme wing tips.

13. SUMMARY

A. Air opposition rated weak to moderate with 21 of 36 B-29's attacked by enemy fighters. No B-29's were lost or damaged due to enemy air action. Preliminary claims against enemy aircraft were 5 destroyed, 4 probably destroyed and 12 damaged.

B. The enemy made 53 single and 13 coordinated attacks for a total of 93 individual encounters. No attacks enroute to target areas. There were 63 encounters in the Primary Target area, 13 in the Secondary Target area and 17 spread out on the route home over China.

C. For the second time since meeting major air opposition encounters from the right quarter were in the majority 41 percent of the total. Another change - 53 percent of the encounters were low.

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OPERATIONS ANALYSIS DIVISION
TWENTIETH AIR FORCE

# HOW TO IMPROVE BOMBING FROM FORMATION

## SUMMARY

Most of the bombs dropped by the USAAF in this war have been dropped from formations ranging in size from 3 to 20 or more aircraft. There is a real need for a simple statement of the inter-relation of pattern size and aiming error and how these govern, for formation bombing, the per cent of bombs which reach the target. If these relationships are made clear to the commanding officers of the bombardment units it will materially assist them in evaluating the performance of their commands and taking the necessary steps to improve their bombing accuracy. Moreover, an understanding of these relationships is indispensable for the estimation of force requirements and for the preparation of a time schedule for a strategic bombardment program.

To this end a very simple chart (see Figure 1) has been prepared which has the following uses:

a. The chart immediately reveals the improvement in the per cent of bombs placed within 1000 feet of the aiming point which will result from (a) a reduction in the size of the bomb pattern; (b) a reduction in the aiming error of the bomb pattern; (c) any combination of these two factors. In consequence of this the efforts of the bombardment group may be made in the direction which will bring about the greatest improvement in the bombing.

b. The unit commander may plot periodically on the chart the aiming error and size of the bomb patterns made by his formations and ascertain whether or not the bombing technique is improving. Comparison may easily be made of the relative progress made by two or more Air Forces, Bomber Commands, Combat Wings, or Groups.

c. The chart, by indicating the per cent of bombs falling within 1000 feet of the aiming point for any average pattern size and aiming error, may be used to guage the relative bombing efficiency of formations of various numbers and arrangements of aircraft.

d. The chart may be used to forecast the effect of altitude on the per cent of bombs falling within 1000 feet of the aiming point if the effect of altitude on pattern size and aiming error is known.

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The report discusses the characteristics of small and large bomb patterns. In Section V there are listed some of the effective measures which may be taken to reduce pattern size and aiming error and thereby increase the per cent of bombs falling within 1000 feet of the aiming point.

I. Pattern Size A Factor In Formation Bombing.

In bombing from formation there is an additional variable not present with individually aimed and released bombs. In the case of the individually aimed bomb the Cep suffices to give an accurate picture of the bombing. Given the Cep, the distance from the A. P. within which half the bombs fall, it is a simple matter to determine the per cent of bombs falling within any other specified distance from the aiming point. For individually aimed bombs the Cep is therefore a convenient and adequate measure of the accuracy, and accuracy of aiming is the sole consideration. The additional variable which must be considered when bombing from formation is the size of the bomb pattern.

This is true because formation bombing which places any specified percentage of the bombs in a 1000 foot circle about the aiming point may achieve this by various combinations of a pattern size and accuracy of aiming the pattern. This becomes obvious from a consideration of two extreme cases, both resulting in placing, say, 50% of the bombs within 1000 feet of the A. P.:

a. At one extreme lies the case where the pattern size approaches the dimension of a single bomb. This is identical with the situation which holds for singly aimed and released bombs. Accuracy of aiming alone determines the result, the Cep of the aimings being 1000 feet since on half the bombs are within 1000 feet.

b. At the other extreme is the case where the aiming error approaches zero. Here the pattern will always be superimposed over the 1000 foot circle about the aiming point and the per cent of bombs falling within this circle will be determined solely by the size of the pattern. If the area of the pattern is just twice that of the area of a circle of 1000 feet in radius there will be just 50% of the bombs falling within the circle, assuming uniform distribution of bombs within the pattern.*

In between these two extremes are combinations of pattern size and aiming error which will result, on the average, in placing 50% of the bombs within 1000 feet of the aiming point. Figure 1 shows these combinations by means of the curve marked 50%. Similar curves have been drawn for 60, 40, 30, 25, 20, and 15 per cent. A bombardment unit, knowing its average pattern size and the average aiming error of the pattern center, can locate itself on the chart and read from the curves

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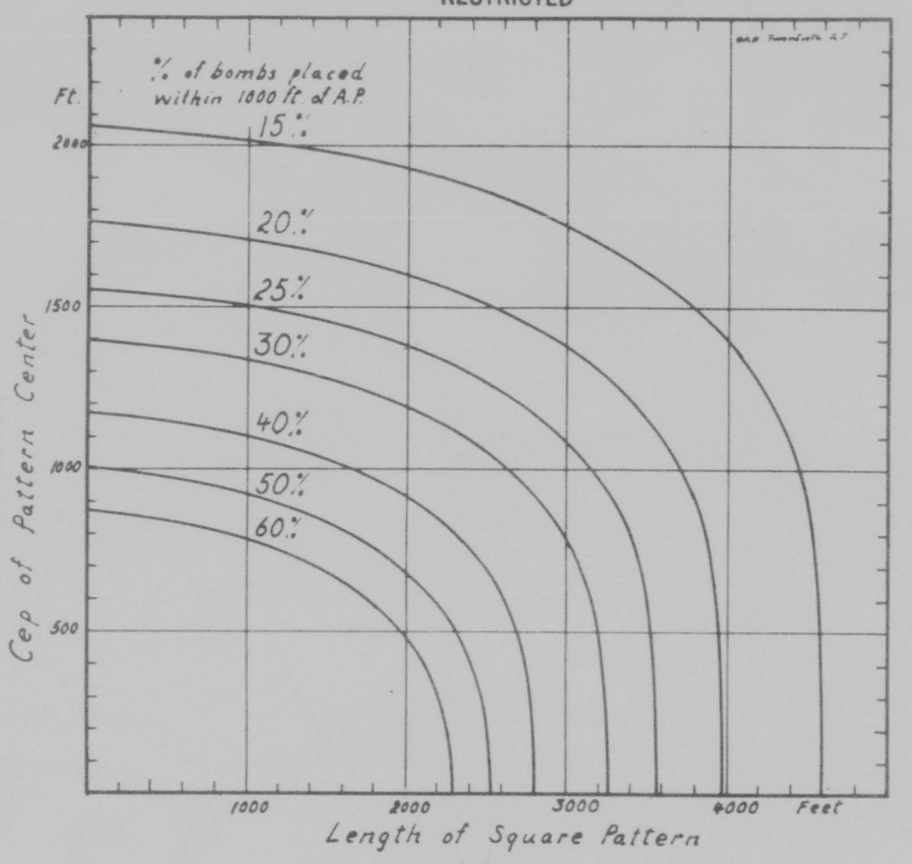


1. Chart shows average per cent of bombs falling within 1000 feet of A.P. given size of pattern and aiming error of pattern center.

2. For patterns not square in shape use side of square of equal area.

3. The same curves and attached percentages apply for the per cent of bombs placed within 500 feet of A.P. if the figures on both the vertical axis and the horizontal axis are divided by 2.

4. Given the per cent of bombs falling within a circle of given radius about the A.P. the per cent expected in a circle of twice this radius is shown below.

| Per cent falling within 500 feet of A.P. | 15 | 20 | 25 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| Corresponding per cent within 1000 ft. | 48 | 59 | 68 | 76 | 87 | 94 | 97 |

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Fig. 1

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the per cent of bombs it will place within 1000 feet of the aiming point. :The pattern size is plotted as the size of a square equal in area to the bombing pattern.** The aiming error is plotted as the Cep of the pattern centers, i.e., .939 times the average distance of the pattern center from the aiming point.***

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* Combat bomb patterns rarely show a uniform distribution of bombs. Patterns usually thin out toward the edges. The effect of this is to make the pattern equivalent to one a little smaller in dimensions. The chart, for that reason, tends to underestimate the per cent of bombs.

** Bomb patterns are usually irregular in outline. The error, for the patterns encountered in operations, of using a square of equivalent area to the pattern, seems to be unimportant in these computations.

*** See Handbook for Bombardiers.



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II. Uses For Formation Bombing Chart.

This chart for formation bombing may be put to several uses:

a. The chart serves an extremely useful function in that it points out the most profitable steps for a bombing unit to take to improve its bombing, once it has oriented itself on the chart. Suppose the bombing unit is at point A (Fig.2) near the 20% curve with pattern area equal to $3600^2$ and aiming error 1100 feet. To progress to the 25% curve, leaving pattern size unchanged, the aiming error would have to be reduced substantially to zero (Point C). On the other hand quite a moderate reduction in pattern size to $3000^2$ (see Point B) will achieve the transition to the 25% curve with no improvement whatever in the aiming of the pattern. It is apparent that, for starting points among the vertical branches of the curves, a much smaller proportionate diminution of the pattern dimension will enable progress to a curve of higher percentage than would be required for the aiming error; contrariwise, if the bombing unit's pattern size and aiming error place it among the upper branches of the curves, the unit should direct its efforts towards a reduction in the aiming error. The chart therefore serves as a guide to the operating units as to where emphasis should be placed to raise their bombing efficiency. Furthermore, it gives a quantitative estimate of the necessary improvement in pattern size or aiming error or both to attain whatever goal is set.

b. On it may be plotted from time to time the performance of a bombing unit as to pattern size and accuracy of aiming of the pattern. This has been done for the Eighth Air Force, the points A through G, (Figure 3) representing some outstanding steps in its progress in bombing effectiveness. The marked reduction in the size of the pattern resulting from dropping on the leader (after an initial period where all aircraft sighted individually for range) and the use of minimum intervalometer or salvo releases was a very large factor in bringing about the great improvement in the per cent of bombs falling within 1000 feet of the aiming point. Part of the reduction in aiming error came automatically with a reduction in pattern size. The smaller pattern is easier to aim because the bombs from the lead ship take on a definite position in the pattern and the lead bombardier is able to make the proper allowance in order to center the pattern on the target.

c. The effect of altitude on the bombing from formation is sharply brought out by making use of certain observations and assumptions of the effect of altitude on pattern size and aiming error. In the European Theater it was found that each additional 1000 feet of altitude added 60 feet to both the length and width of the pattern.

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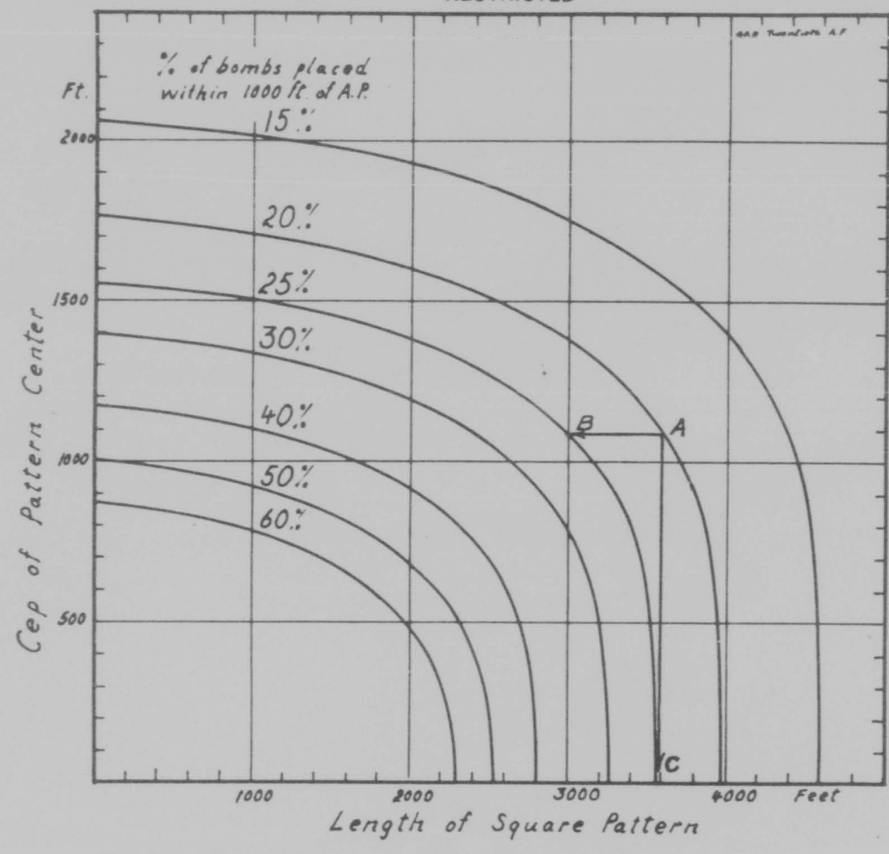


1. Chart shows average per cent of bombs falling within 1000 feet of A.P. given size of pattern and aiming error of pattern center.
2. For patterns not square in shape use side of square of equal area.
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| Per cent falling within 500 feet of A.P. | 15 | 20 | 25 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| Corresponding per cent within 1000 ft. | 48 | 59 | 68 | 76 | 87 | 94 | 97 |

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Fig. 2
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Starting with the average pattern and aiming error at 20,000 feet and assuming a constant mil error, the following table is obtained:

| Altitude | Side of Square Pattern | Aiming Error Of Pattern | % Within 1000 Ft of A.P. From Chart | 8th AF * |
|---|---|---|---|---|
| 15,000 | 1,700 | 690 | 55% | 50% |
| 20,000 | 2,000 | 920 | 40% | 40% |
| 25,000 | 2,300 | 1,150 | 29% | 27% |
| 30,000 | 2,600 | 1,380 | 22% | |
| 35,000 | 2,900 | 1,610 | 17% | |

d. The relative bombing efficiency of various contemplated formations may be estimated by taking the expected size of bomb pattern from each formation. If the same aiming error is assumed for all the patterns the chart indicates for each pattern the expected per cent of bombs falling within 1000 feet of the aiming point.

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* Eighth Air Force data taken from an altitude-accuracy curve prepared in March, 1944.



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III. Characteristics Of Small And Large Bomb Patterns.

The Formation Bombing Chart (Figure 1) indicates that, for the same aiming error, small bomb patterns will place a greater percentage of their bombs within 1000 feet of the A. P. than will result with large bomb patterns. This fact has been fully demonstrated in the European Theater as is shown by the following Table taken from an Operations Analysis Report.*

Classification Of Bomb Patterns By Area

| Area In Million Square Feet | Ave. % Of Bombs Within 1000 Ft. of A.P. |
|---|---|
| 3 or less | 60% |
| 3½ - 5 | 40% |
| 5¼ - 7 | 35% |
| over 7 | 27% |

Despite the fact that in individual instances a small bomb pattern will completely miss the target circle whereas a large pattern with the same aiming error would overlap the target and place some bombs on the target, the advantage lies with the small pattern. The large pattern by virtue of being large can never get a large proportion of its bombs close to the assigned pin point. The small pattern can and does so often enough to far outweigh the complete misses which may be made with the small pattern. Targets are customarily attacked by several formations and it is immaterial if a small pattern misses completely since it is the average for all the formations which is used to appraise the mission. The characteristics of small and large patterns are given more fully in the following paragraphs of this section. They may require some study but they are essential to gaining a realistic picture of pattern bombing.

The discussion thus far has been chiefly concerned with the average per cent of bombs falling within 1000 feet of the aiming point as a result of various combinations of pattern size and aiming error. This average conceals a very important characteristic of pattern bombing, one which has often led unit commanders deliberately to make large patterns. At first glance the risk that a small pattern may completely miss the target would lead to the conclusion that a larger pattern with the same aiming error would be preferable because at least some bombs would fall on the target. This contention can best be examined by breaking down the average per cent and tabulating the frequency with which various percentages within 1000 feet of the aiming point are actually obtained.

* See Report On Bombing Accuracy, 1 October 1943 to 1 March 1944. Operations Analysis Section VIII Bomber Command Report, 12 April 1944.

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For this reason let us choose (a) a small pattern equal in area to the 1000 foot circle about the aiming point, and (b) a large pattern having four times this area. We will assume for each a Cep of 1000 feet for aiming the pattern. It is evident that the small pattern, in many cases, will get nearly all its bombs in the 1000 foot circle about the aiming point. But the large pattern can in no case get more than 25% of its bombs in this circle, because it has four times the area of the circle. It is this fact which is overlooked in dwelling on the danger of mission completely with the small pattern. We are here concerned with targets which require many hits and which will be attacked by several formations. It is not the number of formations which miss completely which matters, so much as the final average for all the attacking formations. Given below is a breakdown which clarifies this matter:

Cep Of Pattern Centers = 1000 Feet For Both Patterns

| (a) Small Pattern Area = Area Of Circle 1000' Radius | | (b) Large Pattern Area = 4 Times Area of Circle 1000' Radius | |
|---|---|---|---|
| % Of Bombs Within 1000 Feet of AP | Number Of Patterns Giving this % | % Of Bombs Within 1000 Feet of AP | Number Of Patterns Giving This % |
| 80 - 100 | 7 | 25 | 50 |
| 60 - 80 | 16 | 20-25 | 27 |
| 40 - 60 | 25 | 15-20 | 11 |
| 20 - 40 | 23 | 10-15 | 7 |
| 0 - 20 | 21 | 5-10 | 4 |
| 0 | 6 | 0- 5 | 1 |
| Total No. Patterns | 100 | | 100 |
| Av % Within 1000 Feet Of AP: | 40% | Av % Within 1000 Feet of AP: | 22% |

The breakdown shows that it is to be expected that 6 of the small patterns will miss completely, whereas only one out of 100 large patterns will place fewer than 5% of its bombs within the 1000 foot circle about the A. P. Not only that, but 77, or over three quarters of the large patterns will be in the 20 to 25% bracket, giving a very high assurance to a single attack. But when the average per cents within 1000 feet of the A. P. for these two patterns are computed, it is found that the small pattern is placing nearly twice the percentage in the 1000 foot circle. To unit commanders, as well as those at higher levels, this is an extremely valuable concept, namely, that a pattern which misses the target more often than another pattern may yet make for better bombing.

Bombing from formation necessarily means more fluctuating results than single A/C attacks due to the smaller number of aimings. That these are predictable is demonstrated by examining the per cent of bombs placed within 500 feet of the A. P. by 100 consecutive normal aimings of Eighth Air Force

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patterns in the early part of 1944:

| % Of Bombs Within 500' Of Aiming Point | 100 Eighth Air Force Patterns | Predicted Results With Pattern 1800 Feet Square Cep Equal 875 Feet |
|---|---|---|
| over 25% | 24 | 20 |
| 20-25% | 12 | 17 |
| 15-20% | 14 | 13 |
| 10-15% | 13 | 12 |
| 5-10% | 16 | 11 |
| 0- 5% | 10 | 13 |
| 0% | 11 | 14 |
| | 100 | 100 |

The fact that the result obtained with a single aiming of a small pattern may vary from zero to a very high percentage of bombs within 1000 feet of the A. P. is largely overcome by the policy of sending several formations to attack the same target. Even as few as four formations greatly stabilize the result, as shown below:

Small Pattern: Area = Area of 1000' Radius Circle; Cep of Pattern Center 1000'

| % Of Bombs Within 1,000 Feet of A. P. | Distribution Of 100 Single Patterns | Distribution Of 100 Averages Of 4 Patterns |
|---|---|---|
| 80 - 100 | 7 | - |
| 60 - 80 | 18 | 7 |
| 40 - 60 | 25 | 42 |
| 20 - 40 | 23 | 44 |
| 0 - 20 | 21 | 7 |
| 0 | 6 | - |
| | 100 | 100 |

This shows that the composite result of as few as four formations is greatly stabilized since 86% (or 6 out of 7) of the targets attacked fall in the bracket 20% to 60%. This still may seem a wide range to occur in the normal course of events but it is inseparable from the inherent character of pattern bombing.

In this connection it is well to remember that the centers of several patterns aimed independently at the same aiming point will be dispersed in the same manner as singly aimed bombs. The patterns, therefore, overlap one another and the target area in varying degrees. As an instance of this it has been computed (6)* that on the average, in the case of four bomb pat-

*Report No. 1, OAS, XXI Bomber Command, 16 November 1944.

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terns each 3000 feet square aimed at a target 2000 feet square with a Cep of 1177 feet, 2% of the target area will be missed completely.
11% of the target area will be covered with 1 pattern.
31% of the target area will be covered with 2 patterns.
38% of the target area will be covered with 3 patterns.
18% of the target area will be covered with 4 patterns.

Formations cannot be expected to superimpose their patterns like pancakes on a breakfast plate. Indeed only a small part of the target is covered with the maximum density. Every effort to date to increase this density by making the smallest possible patterns has not led to over bombing of the industrial targets. Damage appraisal reports on loss of production for the enemy targets attacked still leave much to be desired.

IV. Pattern Dimensions And Aiming Errors Should Be Recorded.

The utility of the Cep as a measure of the bombing in the case of individually aimed bombs was referred to in the beginning of these notes. The preceding discussions show how unrevealing the Cep (if, as seem to be usually the case, is meant the radius of the circle about the A. P. which contains half the bombs dropped) is when applied to large-pattern formation bombing. Contrary to the case of individually aimed bombs, such a figure no longer bears any simple relation to the skill of the bombardier. Reference to the chart will show that a pattern 3700 feet square, aimed with a Cep for pattern centers of 1000 feet, will place on the average only 20% of its bombs within 1000 feet of the A. P. In this instance it is estimated that, bombing with such a pattern, half the bombs will fall within 1770 feet of the A. P. and this may therefore be called the Cep of the bombs. By association it is assumed that the bombardiers are turning in a poor performance. Actually they are performing the difficult task of aiming a very large pattern so that half the pattern centers lie within 1000 feet of the A. P. The measures called for to improve the bombing must be directed to a drastic reduction in the size of the pattern. Another bombardment unit may also place 20% of its bombs within 1000 feet of the aiming point by means of a pattern 2000 feet square but with a Cep for the pattern centers of 1600 feet (see chart). In this situation it is urgent that steps be taken to reduce the aiming error. The same so called Cep of the bombs, when applied to formation bombing, conceals diametrically opposite problems and in view of the confusion its use entails, its meaning should be carefully specified when applied to formation bombing.

Data from the theaters is now commonly expressed in per cent of the bombs dropped which fall within some simple multiple of 1000 feet of the A. P. Every effort to collect in addition records on pattern sizes and aiming errors should be made.

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The center of the pattern may be determined (a) by inspection; (b) by taking the center of a circle of 500 feet (or 1000 feet) radius so placed over the pattern as to include the largest number of bombs; (c) by taking the intersection of a pair of lines parallel to and at right angles to track, each of which has one half of the bombs on each side of the line. The use of the MPI is not recommended because it is tedious to compute and because stray bombs exert an undue influence. Once the center of the pattern is determined the radial distance to the A. P. is recorded. The average of these distances when multiplied by 0.939 gives the Cep of the pattern centers. (See Handbook for Bombardiers).

The size of the bomb pattern may be taken as the dimensions of a rectangle (one edge parallel to track) which substantially encloses the bomb fall. Obvious stray bombs including an early or late release from one of the aircraft in the formation are disregarded.

A detailed account of the procedures for making these measurements including the technique for making bomb plots of individual patterns from the strike photographs is available in an Operations Analysis Memorandum.*

V. Reduction Of Pattern Size And Aiming Error.

The per cent of bombs placed within 1000 feet of the A. P. will be increased (a) by diminishing the area of the bomb pattern; (b) by decreasing the average aiming error; (c) by reducing both. The chart indicates directly for any current operating performance where the emphasis should be placed.

The area of the pattern may be diminished by:

a. Maintaining a better formation on the bomb run by holding proper position in the formation and striving for a common speed and heading for all the aircraft in the formation.

b. Achieving as nearly as possible a simultaneous release of the bombs from all the aircraft in the formation.

c. Using minimum intervalometer or salvo release.

d. Automatic Bomb Release.

The aiming error may be decreased by:

a. Standardization of the bomb pattern so as to fix the position of the lead bombs with reference to the center of the pattern. This enables the bombardier in the lea d aircraft to make the appropriate offset in his sighting so that the bomb pattern will be centered on the target.

*Memorandum on Methods of Analysis and Reliability of Measures Employed in the Study of Bombing Accuracy. Operations Analysis Section, Eighth Air Force. This, and other Operations Analysis Reports, may be obtained from Operations Analysis Division Hq. AAF.



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b. Making practice runs. If the lead aircraft carries large bombs they may be identified in photographs. They should be moved back in the plot for the known difference in range between the large bombs and the small practice bombs carried by the other aircraft. This will place the lead bombs in their usual position in the bomb pattern and reveal the required offset.

c. Careful choice of lead crew.

d. Automatic Bomb Release.

Formation bombing requires more than teamwork within the members of the crew of a single aircraft. Formation bombing requires teamwork among all the aircraft in the formation. Bombing results depend very greatly upon the bomb pattern not only because of the direct effect of the size of the pattern but because a good bomb pattern can be aimed more successfully than a poor pattern. The pilots play a most important part in making a good pattern. The wing bombardiers, acting on signal from the lead aircraft, merely determine when the bombs go away; the wing pilots determine where the bombs go. A difference in heading of three degrees from that of the lead ship will bring about a lateral displacement of the bomb by 600 feet from 20,000 feet altitude. This explains why bomb patterns on the ground are often twice as wide as the formation is in the air. Bombardiers did not make these patterns wide. Wing bombardiers can, by not acting promptly on signal from the lead ship, make the patterns string out. An automatic bomb release activated by the lead ship will remove this difficulty but will not remove the necessity for flying a good formation in order to control the width of the pattern.

The task of the lead bombardier is to aim the pattern at the target. This is a more difficult task than aiming a single bomb. Obviously he must have something to aim. A ragged pattern cannot be successfully aimed. When a formation learns to reproduce a standard pattern the lead bombardier soon discovers what he must do to aim the pattern. The automatic bomb release should fix more certainly than ever before the position of the lead bomb in the pattern and enable the lead bombardier to aim the pattern with a precision more nearly equal to that which he can attain with single bombs.

In theory formation bombing can never equal in effectiveness the bombing done by individual aircraft. The formation has been accepted (a) as a method of defense; (b) as a means of getting a large force over the target in a short interval; (c) to facilitate the efforts of the escort fighters to protect the bombers. It is quite possible that the bombing from formation of moderate size is not appreciably less effective than single attacks. The formation enables the unit to capitalize on the superior attainments of the lead crew which certainly have a greater assurance of identifying the target and making the sighting operation under adverse conditions than would be true of the average crew. In addition the bomb patterns from each

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formation may be identified and faults detected and technique improved. This will not be possible for individual attacks. In this case every crew viewing the composite bomb plot believes their own bombs are near the aiming point and it was some other crew which missed the target. This was also true of formations until a technique of identifying bomb patterns was developed. The ability to recognize good work, to test and select the most effective techniques has proved to be a very important factor in the great advances made by the Army Air Forces in bombing effectiveness.

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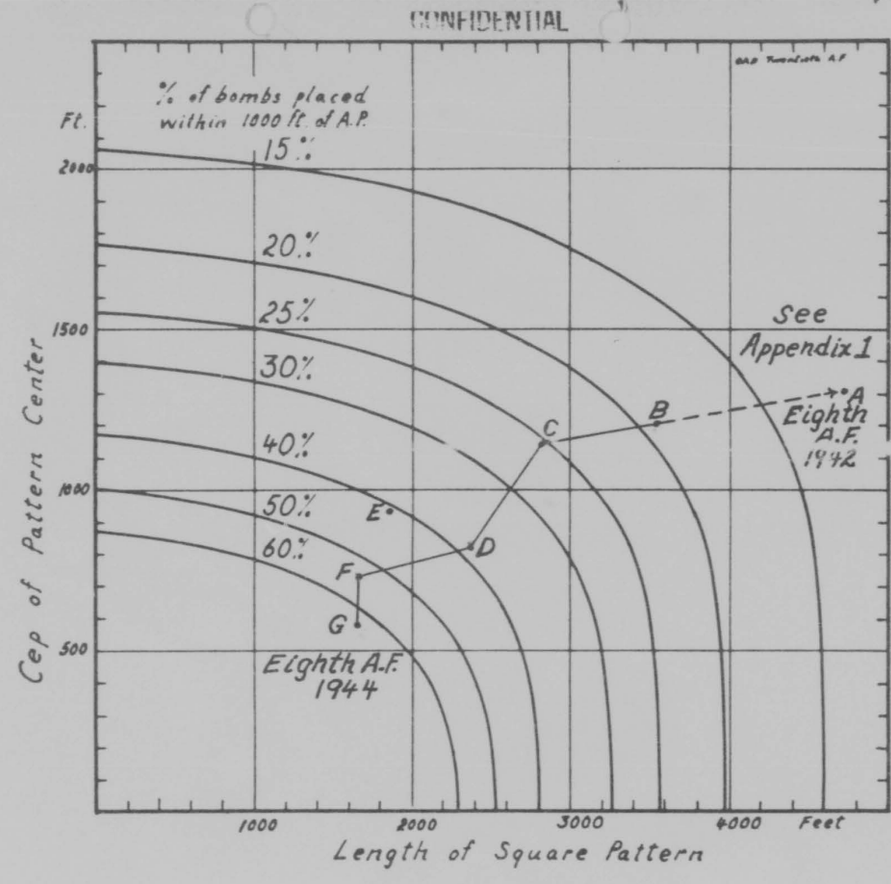


1. Chart shows average per cent of bombs falling within 1000 feet of A.P. given size of pattern and aiming error of pattern center.

2. For patterns not square in shape use side of square of equal area.

3. The same curves and attached percentages apply for the per cent of bombs placed within 500 feet of A.P. if the figures on both the vertical axis and the horizontal axis are divided by 2.

4. Given the per cent of bombs falling within a circle of given radius about the A.P. the per cent expected in a circle of twice this radius is shown below.

| Per cent falling within 500 feet of A.P. | 15 | 20 | 25 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| Corresponding per cent within 1000 ft. | 48 | 59 | 68 | 76 | 87 | 94 | 97 |

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Fig. 3

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Appendix 1

## Progress of Eighth Air Force Bombing

| Point (See Chart) | Time | Pattern Size Length | Width | Cep Of Pattern Center | Av % Of Bombs In 500' | 1000' | Comment |
|---|---|---|---|---|---|---|---|
| A | 1942 | Over 1 Mi long | | - | no reliable records | | |
| B | 1943a | 4,600 | 2,600 | 1,180 | | 12% | Individual sightings for range. |
| C | 1943a | 3,200 | 2,500 | 1,130 | | 24.6% | Drop on leader. |
| D | Oct 1 1943 Mar 1 1944b | 2,600 | 2,200 | 820 | | 37% | Minimum intervalometer. Some salvo. |
| E | 1944c | 1,900 | 1,900 | 940 | 15% | | Minimum intervalometer. |
| F | 1944c | 1,700 | 1,700 | 740 | 24% | | Salvo. |
| G | 1944c | 1,750 | 1,700 | 600 | 25% | | 12-14 A/C formation. |

a. See Analysis of VIII Bomber Comma nd Operations from the point of view of Bombing Accuracy. Operations Analysis Section Report, 31 October 1943.

b. See Report On Bombing Accuracy, 1 October 1943 to 1 March 1944. Operations Analysis Section VIII Bomber Command Report, 12 April 1944.

c. See Memorandum on Salvo and Intervalometer Releases, Operations Analysis Report, Eighth Air Force, 16 September 1944. Data for points E, F, G, are for patterns in the altitude bracket 18,000 - 22,500 using 500 lb. bombs from B-17 A/C. Point E is not included in the line on the chart showing the progress of the Eighth Air Force because the data for this point is based on patterns dropped over an earlier period of time. They were segregated to show a comparison between salvo and intervalometer releases. Except for point G the data refer to patterns made by combat boxes of 18-21 A/C.

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2 January 1945

MEMORANDUM TO CHIEF OF STAFF, TWENTIETH AIR FORCE.

Subject: The Need for Adequate Weather Reconnaissance for the Twentieth Air Force.

Table of Contents:

1. Weather and Bombing Results.
2. Forecast Errors.
3. The Answer - Weather Reconnaissance.
4. Weather Reconnaissance for the Twentieth Air Force
5. Conclusions, Recommendations and Anticipated Results.

1. Weather and Bombing Results:

a. Basis for this report are the mission reports of the XX Bomber Command. Between 5 June and 27 November 1944, the XX Bomber Command flew, among others, 2 combat missions each against Bangkok, Anshan and Omura. One of the missions against each target encountered good weather over the target, the other poor weather. The results achieved on these missions were analysed. They enable one to show the effect of target weather on present bombing accuracy. The mission pairs chosen were numbers 1 and 18 (Bangkok), 4 and 9 (Ashan), 13 and 16 (Omura).

b. A complete tabulation of comparable numerical data for each pair of missions appear in table II at the end (of paragraph 1) of this report. The results of the analysis can briefly be summarized as follows:

Table I:

| Three Missions Each: | Bad Target Weather: | Good Target Weather: |
|---|---|---|
| Total No. A/C over Target | 179 | 174 |
| % of A/C Airborne at forward bases | 59 | 84 |
| Mean cloud cover below A/C at primary Target | 9/10 | 1/10 |
| % of identified bomb hits within 3000 feet of aiming point | less than 1 | 80 |
| Total of N. A/C lost on missions (Regardless of cause) | | |

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| Three Missions Each: | Bad Target Weather: | Good Target Weather: |
|---|---|---|
| Total No. of A/C damaged on missions (Regardless of cause) | 28 | 32 |
| Total No. of casualties on missions | 80 | 43 |
| Mean Consumption of gasoline per A/C bombing primary, in gals. | 6222 | 6031 |

c. Superficially viewed the data given in Table I indicate that when poor weather prevailed over the target:

(1) With the same number of aircraft over the target bombing results achieved were 79% poorer,

(2) Less aircraft of those dispatched reached the primary targets,

(3) Loss of aircraft and casualties were higher,

(4) Gasoline consumption was 3½% higher (200 gallons per A/C per strike),

than in cases when good target weather prevailed.

More strictly interpreted the above given data show that with poor weather over the target the efforts were wasted, if one considers that the purpose of a combat mission is to put the bombs on the target. In the three poor weather missions, with negligible bombing results,

10 airplanes (B-29) were lost.
28 airplanes (B-29) were damaged.
80 highly trained men became casualties.
2663 bombs were scattered and over 1.2 millions gallons of galoline were burned in vain.

* Numerical comparison is not possible because in case of mission number 16 part of the effort was re-directed after take-off because of a forecast revision, but many A/C failed to receive the message. In the other two pairs of missions at least 10% more airplanes reached the target in good weather than in bad weather.

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TABLE II

| Mission Number | Date | Target | Type Bombing | Cloudiness Below A/C Obs. | Cloudiness Forecast | A/C Airborne | A/C Bombing Primary | % of Airborne % Bombing Pri. | #A/C Lost | #A/C Damaged |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 June 44 | Bangkok | Radar | 7-10/10 | 8-8/10 | 98 | 77 | 79 | 5 | 3 |
| 18 | 27 Nov 44 | Bangkok | Visual | 0 | 2-4/10 | 60 | 55 | 92 | 0 | 12 |
| 9 | 26 Sept 44 | Anshan | Mainly Radar | 8-10/10 | 4/10 | 105 | 73 | 69 | 0 | 15 |
| 4 | 29 July 44 | Anshan | Visual | 3/10 | 2-4/10 | 72 | 60 | 83 | 3 | 7 |
| 16 | 11 Nov 44 | Omura | Radar | 10/10 | 3/10 | 96 | 29* | 30 | 5 | 10 |
| 13 | 25 Oct 44 | Omura | Visual | 0 | 4/10 | 78 | 59 | 76 | 2 | 13 |

* Attempt was made to re-direct A/C after take-off when weather data indicated poorer target conditions than had been forecast, but many A/C failed to receive message.

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| Killed | Missing | Wounded | Bombs Dropped On Primary | #Bombs Identified 0-3000' from AP | % of bombs identified 0-3000' from AP | Mean Gas Consumption per A/C (gals). |
|---|---|---|---|---|---|---|
| 15 | 2 | 8 | 1472 | 18 | 1.2 | 6066 |
| 0 | 11 | 4 | 1529 | 1040 | 90.7 | 5265 |
| 1 | 0 | 2 | 731. | 0 | 0 | 6152 |
| 8 | 3 | 3 | 448 | 205 | 67 | 6067 |
| 2 | 47 | 3 | 456 | 0 | 0 | 6448 |
| 12 | 0 | 2 | 624 | 263 | 81 | 6760 |

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2. Forecast Errors:

a. Although the mission reports do not disclose in how far command decisions were influenced by the weather forecast, it is clearly indicated that in the three abortive missions approximately 4/10 cloudiness over the targets had been forecast but around 9/10 was encountered.

b. It would be easy to place the blame for these failures on the forecasters involved. However, even the best forecaster cannot be expected to make reliable forecasts with insufficient data. One of the most difficult forecasting problems is a pin-point forecast on cloudiness for a place over 1000 miles distant 24 or more hours in advance. The density of observing meteorological stations available to the forecasters in the Far Eastern area is much less than necessary for good forecasting. The number of available upper air observations (pilot balloons and radiosondes) are far below U. S. standards. Considerable areas in the Far East are blank spots on the weather maps, partly because of occupation by enemy forces, partly because from vast ocean areas only a few weather reports are available. Furthermore, forecasters in a theater of war are always plagued by communication and ciphering problems.

c. Lack of adequate data in conjunction with the present state of knowledge in meteorological science would make it unfair to place the blame for forecast failures in the theater of war on the weather service. Even in peace-time Far Eastern weather presents some of the toughest problems to the meteorologist. Even when more experience is gained by U. S. weather personnel in the theater no radical improvement of forecasts can be expected in the near future, unless the forecasters are provided with much more comprehensive observational material than heretofore.

d. During many months of the year only a few clear days can be expected over the majority of Far Eastern targets. To forecast these days is a most important task in order to enable the commands to exploit to the fullest these occasions which will make pin-point bombing of strategic targets possible. For many months to come, even with the best available radar techniques, visual bombing will be necessary to achieve the destruction of pin-point targets with a minimum number of missions.

3. The Answer - Weather Reconnaissance:

a. The problems presented in paragraph 1 and 2 above are not new ones. They have been encountered before in air operations over Western Europe, in the Mediterranean and over the North Atlantic. The answer in all these cases - even though at times only reluctantly accepted - has been weather reconnaissance.

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b. Weather to the aviator is the same as terrain is to the infantry man. In unknown territory, terrain reconnaissance is always carried out in advance of ground operations. How much more is reconnaissance needed in the atmosphere which has no fixed features and where changes are so rapid in time and space?

c. That weather reconnaissance is effective has been proven, wherever the right kind of air planes in sufficient number, with proper equipment and specially trained personnel were provided for the purpose. Evidence to that effect is presented in an appendix to this report giving pertinent quotations from official publications.

d. At the time of this writing there is, e.g., a weather reconnaissance squadron in the North Atlantic, flying 6 fixed courses each day (3 from Iceland, 3 from the Azores). This squadron, flying about 1000 hours each month, delivers about 1400 observations per month to the forecasters. In Western Europe seven squadrons (RAF and USAAF), 2 of them from the Eighth Air Force fly daily reconnaissance missions over fixed courses from England, Ireland, Scotland, the faroes and in addition weather target missions over enemy held territory. In the operational region of the 15th Air Force a weather reconnaissance squadron keeps a close check on the difficult alpine weather conditions and the weather over German targets beyond the mountain barrier. All this is found necessary, and extremely helpful, in spite of the fact that our knowledge of weather in Europe is far superior to most other regions of the world, that the station network for surface and upper air data is very dense and the distances to be flown in combat rarely exceed 500 miles.

e. The Weather Reconnaissance procedure employs, side by side, two techniques:

(1) The flying of fixed courses at regular hours.

(2) Spot checks of weather over targets.

From the view point of the forecaster the first type of reconnaissance is by far the most important and useful one. The data from these flights are received regularly and they improve weather analysis and forecasts materially. In europe, for example, many important meteorological events, such as fronts, could have never been foreseen without these regular weather reconnaissance flights. The spot checks are helpful as a last minute forecast verification. If they are long before the contemplated target time they loose much of their effectiveness. Because of the irregularity of these flights in time and space they contribute relatively little to the improvement of forecasts.

4. Weather Reconnaissance for the Twentieth Air Force:

a. At present the XXI Bomber Command flies weather strike missions on as many nights as feasible. Plans call for the employment of the specially trained 655th Bomber Squadron (H) equipped with B-24's for weather reconnaissance in the Pacific area early in 1945.



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b. Any sort of weather reconnaissance is, of course, better than none but it should be realized at an early date that the procedure now in use or contemplated is far from fulfilling the needs. Compared to the North Atlantic and Europe much less is known about forecasting weather conditions over Far Eastern target areas. Therefore, weather reconnaissance should be flown in such a fashion as to enable the forecaster to achieve optimal success. If it is recognized that weather is a factor of prime importance is strategic bombing then it is clear that weather reconnaissance is coupled with other aims such as incidental bombing, photographic reconnaissance, radar reconnaissance, etc, it loses much of its effectiveness. These other aims are not compatible with the purpose of weather reconnaissance. The most important areas to be reconnoitered from a meteorological point of view are rarely the target areas which it is desirable to bomb or for which photographs or radar coverage are wanted. Also, weather reconnaissance by night by visual means, is only a very poor substitute for what is really needed. Weather reconnaissance reaches its maximum efficiency when a full complement of thoroughly trained observers are on the airplance and equipment for upper air data are installed. Finally, the planes used for weather reconnaissance should have the same or, preferably, a greater range than the distance of the missions to be flown.

c. The use of a squadron of B-24's, even if exclusively used for weather reconnaissance, in the Pacific area will from a meteorological point of view, be insufficient to solve the weather problems of the Twentiteth Air Force.

(1). From the present bases the range of these planes is too small to burnish the necessary data. The old proverb applies here that one should not send out a boy to do a man's job.

(2) Even if advanced bases are secured which will bring the target area within striking distance of the B-24's, these planes will not be suitable for target weather reconnaissance in day time. Because they have to radio weather information back, in order to make it immediately useful, these planes can be tracked readily by enemy monitors. This will lend to interception and these planes are too slow to escape enemy fighters.

(3) Weather reconnaissance airplanes in order to be fully effective should be equipped to drop radiosondes at fixed intervals. Experiments with such equipment have been conducted but progress has been very slow. The needs of the Twentieth Air Force require that promising leads in this instrumental development be exploited rapidly and equipment be made available at the earliest possible date for Pacific weather reconnaissance.



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5. Conclusions, Recommendations and Anticipated Results:

a. The following conclusion can be drawn:

(1) On comparable combat missions the XX Bomber Command achieved no bombing results when weather conditions over the targets were poor.

(2) Because of inadequate weather data the pin-point target forecasts are poor. Adequate weather reconnaissance, as experience in other theaters of war shows, is the answer to the problem.

(3) The effort wasted on 3 resultless combat missions would have sufficed to run daily weather reconnaissance for the XX Bomber Command for a half year. The A/C losses suffered on these abortive missions would have constituted nearly a full weather reconnaissance squadron.

(4) The present and now contemplated weather reconnaissance for the Pacific area is inadequate.

b. The following recommendations are made:

(1) Each of the constituting Bomber Commands of the Twentieth Air Force should have a weather reconnaissance squadron of long-range, well defended, fast airplanes. (At present only B-29s are adequate for the job). These airplanes should be equipped with the latest meteorological equipment and manned with trained personnel to give maximum information to the weather service.

(2) Weather reconnaissance missions should be flown solely for weather purposes and be completely divorced from all other distracting duties. Most of the weather reconnaissance should be flown regularly on fixed courses selected by weather personnel for the purpose of filling in gaps in the existing weather information.

(3) The weather reconnaissance airplanes should be equipped to make radiosonde descents while in flight. The agencies concerned with developing and procuring the necessary equipment should be instructed to rush their experimental work to the point where such equipment can be delivered to the operating squadrons at the earliest possible moment.

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c. If the plan outlined in paragraph 5 b. above is followed, the following results can be anticipated:

(1) An improvement in the weather forecasts resulting in the reduction of abortive missions flown.

(2) Greater success in forecasting good weather over the targets leading to a maximum exploitation of such opportunities for strategic pin-point bombing.

H.E. LANDSBERG
Operations Analyst

APPROVED BY:

ROBERT L. STEARNS, Chief,
Operations Analysis Division,
Twentieth Air Force.

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APPENDIX

Excerpts from Article by Lt. John B. Blake, entitled, "North Atlantic Icing", in Weather Service Bulletin Vol. 2, No. 5, November 1944, p. 17.

The North Atlantic Wing of the Air Transport Command faced the responsibility of cargo and ferry operations across one of the world's more dangerous air routes in winter weather, long recognized as severe and treacherous.— To promote safe operation, extensive weather reports were indispensable. Gaps between reporting stations on the North American mainland, on Greenland, Iceland, and on the British Isles had to be filled in by radio reports from weather reconnaissance aircraft which could investigate pertinent areas and levels. C-54 cargo planes were assigned to this duty, and teams of forecasters from the 8th Weather Squadron made the extensive observations required.

Excerpts from an Article by Captain E. E. Churchill, entitled, "Weather or Not", in Air Force, December 1944, pp62-63.

Less than a year ago, unpredictable weather was costing the 15th Air Force an average of three or four abortive missions a week. Dozens of others were being grounded by the uncertainty of weather conditions enroute and over the target. Precious time and gasoline was being squandered by flying three or four hours toward targets, only to find them overcast. Failure to utilize the maximum number of bombing days was giving the enemy an opportunity to put his factories back into operation before they could be paid encore visits.---Weather was at the root of these uncompleted missions, but weather forecasters were not to blame.---There had to be a practical solution to these problems. The 15th found it in weather reconnaissance.

In less than a week after the organization of the detachment, abortive missions had been practically erased. By the end of February, weather reconnaissance flights had been officially credited as the decisive factor in the success of 15 missions that otherwise would not have been attempted.---Missions flown by weather reconnaissance are roughly divisible into three principal categories. First, there are the general area mission. Second, Target check missions. Third, Pathfinding missions to locate openings.---The observation planes are most useful in making sure that time is not wasted in going to impossible targets, and that a clear target is not passed up.---Weather reconnaissance, one of the newest and most promising phases of strategic bombing, received its greatest tribute in a recent statement---with no strings attached ---made by A-3 of 15th Air Force. It was that the operations of the reconnaissance unit had slashed at least six months from the length of the war in the Mediterranean by making it possible to carry out continuous bombing strikes.

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"German Weather Reconnaissance", from interview with German officer P/W
(15 November 1944)

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German Weather Reconnaissance:

a. A great deal of importance was attached by the German Meteorological Service to airplane ascents and meteorological reconnaissance. Not only were airplanes always made available by the High Command of the Luftwaffe for this purpose, but also the officers flying weather ascents and reconnaissance received high awards after completing a certain number of these flights.....

b. Many of the reconnaissance flights were long distance flights and fourmotored aircraft was regularly allocated to these flights. At times, even six motored long distance airplanes were allocated to the weather reconnaissance squadrons of these long distance flights, three were made regularly every day.....

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destroyed, in one single attack. On the other hand, with considerable cloudiness below the level of attack, necessitating the use of radar, bombing accuracy leaves much to be desired. Under those weather conditions many repeat performances over the same target are called for. Each operation, no matter whether it offers opportunity for visual bombing or not, is potentially costly. Normally, one can expect to loose just as many men and aircraft, to expend as many bombs and gallons of gasoline for a radar mission as for a visual mission. The results, however, are, as pointed out before, specacularly different. I would therefore call the target cloudiness forecast the most important single operational weather problem. Anything that can be done to improve that type of forecast will increase the effectiveness of the strategic air force and any effort toward that end seems worth considerable expenditure in manpower and funds.

For area attacks with incendiary bombs weather conditions other than cloudiness are of considerable importance for the scale of success achieved. A combination of low relative humidity, lack of rainfall in the period preceding and immediately succeeding the attack and high wind speeds at the surface are highly desirable for optimum results. If a choice of days favorable for such attacks can be made on the basis of weather forecasts, again a smaller number of missions will be required for the reduction of a target than if less favorable weather conditions prevail.

Last, but not least, the forecast of the wind vector at bombing altitude is of importance for planning the axis of attactk, and this wind forecast in combination with good forecast for all levels down to the surface will make ballistic corrections possible that contribute to bombing accuracy.

It is, of course, essential for the achievement of the main purpose "bombs on the target" that the aircraft gets over the target with a minimum expediture of fuel and then gets safely back to its base. Poor weather conditions en route requiring to burn excessive quantities of gasoline and preventing, for the daylight missions, the flying formation result in losses.

In POA, in the past, airplanes that ran out of gasoline have had no other choice but ditch and with the understandable difficulties in Air - Sea rescue, there have been deplorable losses of life. Good forecasting can contribute greatly to the safety of the non-combat portions of the flight. It will especially help in navigation. It can be readily visualized that flights requiring a 3000 mile round trip strain the faculties of navigators to the limit. Under instrument weather conditions the task to arrive at the target is not easy. For radar missions it is very vital that navigation will bring the aircraft to the proper point on the enemy coast where it is possible to identify



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HEADQUARTERS [illegible] AIR FORCE
Operations Analysis Section
APO 234, c/o Postmaster
San Francisco, California

FFF/elw;vrc

10 August 1945

MEMORANDUM FOR MR. LeROY A. BROTHERS, CHIEF, OPERATIONS ANALYSIS SECTION, TWENTIETH AIR FORCE.

SUBJECT: Temperature and Airspeed Indications from B-29 Aircraft.

1. Attached as Appendix 1 are three (3) outside air temperature calibration graphs for the navigator's, bombardier's, and engineer's instruments on B-29 No. 44-737. These instruments are standard production indicators, calibrated for test data reduction purposes. It will be seen that instrument errors are of the magnitude of 1° C. Radiation influences are assumed by the test unit to be 1° C. when the sun rays strike perpendicularly the skin of the airplane around the projecting temperature element.

2. Navigator OAT gages have been found to read lower in a number of cases and some navigators, it is learned, have in some cases used the average of the three or the bombardier's reading exclusively for their computations. It is not known whether this information is at the disposal of all combat navigators. Observation on test flights in the near future will be made to evaluate variations due to position.

3. Investigation of OAT compression error charts from bombing documents reveal that the correction factor used is .82 of the formula:

Correction in Deg. C = (.82)(V/100)2
Where V/T = true airspeed in mph (Statute)
and .82 = correction factor

The Twentieth Air Force Navigator informs me that the following corrections are directed to be used:

| Airspeed IAS MPH | Correction in Deg. C. For Navigator's OAT Test |
|---|---|
| 150 | -2.7 |
| 180 | -3.4 |
| 200 | -4.2 |
| 225 | -5.4 |
| 250 | -6.8 |
| 275 | -8.0 |
| 300 | -9.0 |

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By investigation, it was found that this corresponds to a correction factor of 1.05 as applied in the formula above. Assuming that the factor .56 reported in Landsberg's letter is accurate, the OAT correction for 300 mph TAS (200 CAS at 25,000) as given by the Twentieth Air Force table is approximately 2 mph lower than it actually would be. Accepting the approximation that an error of 1 mph TAS is equivalent to a 50' aiming error, a 2 mph variation is computed from actual airspeed would invite an aiming error about 100 feet short. Graded by present bombing practices, this is negligible.

4. The E6B or G-1 navigator computers are accurate and dependable if used properly. To determine TAS by use of the E6B, it is necessary to correct indicated OAT for compressibility and to correct CAS to TIAS by application of the airspeed system compressibility correction before entering the computer. The G-1 requires that a compressibility correction only be made for OAT as the conversion from CAS to TIAS is accomplished in the arrangement of the scales. Thus, assuming the devices are used correctly, there is no reason to doubt their accuracy. Under present combat operating procedures (200 CAS at 25,000):

a. The maximum error which might result from use of the G-1 computer without applying the OAT compressibility correction is in the order of ± 6 mph (stat).

b. The maximum error which might result from the use of the E6B, neglecting the compressibility correction for both OAT and CAS is about 6 ± 3 = 9 mph (stat). This estimate is considerably less than that recorded in paragraph 4 of Mr. Landsberg's letter.

5. The use of the Cruise Control Chart as suggested by Mr. Gene Williams is subject to limitations:

a. The Calcit chart device used to convert pressure altitude to density prior to entering the airspeed conversion grid must have the OAT on which its use depends corrected for compressibility the same as the G-1 or E6B computer.

b. The airspeed grid is based on pilot's indicated airspeed (IAS) to TAS, which means that:

(1) Instrument error is assumed to be 0 (instruments, on the average, can be in error as much as ± 3 mph (stat), which is a 6 mph spread).



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(2) Position error is assumed to be the same for all production B-29's.

(3) Compressibility effect on the B-29 airspeed system is assumed to be a function of $V_1$ (CAS). See Appendix 2.

This bridges a number of points which can, cumulatively, cause an error in true airspeed determination as great as that resulting from use of the E6B without correction for compressibility on OAT and airspeed. There are no Boeing Cruise Control Charts available, as charts of this type have been obsoleted for use since arrival of the XXI Bomber Command in this theater.

6. Another point not covered in Mr. Landsberg's letter is the questionable reliability of the speed course method of calibrating airspeed systems. At present each navigator is directed to calibrate his own. Assuming that all navigator skills are not equal, and that variations in interpretations of the separate OAT systems as pointed out in Mr. Landsberg's letter do exist, calibration errors can result. Logs of airplanes flying in formation traveling at ± 6 mph CAS from that flown by the leader have been recorded.

7. Various and sundry calibration techniques employed by separate units of the Twentieth Air Force need to be simplified, improved, and standardized. A scheme advocated by the Flight Engineer Operations Analyst of the Twentieth Air Force has been under passive investigation for some months. A recent publication (Appendix 3) by Boeing Aircraft substantiates this proposed airspeed calibration technique. A device for evaluating position, compressibility, and instrument error is incorporated in the Flight Engineer's Computer being published in its final form at this time.

FREDERICK F. [illegible],
Operations Analyst,



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APPENDIX 3

Item 14 of
Section 13

June 12, 1945

SUBJECT: B-29 AIRSPEED COMPUTATION

It has recently come to the attention of the service department that field personnel are not considering all the factors involved when computing true airspeed from an indicated airspeed reading. The following factors affect airspeed computation and must be considered in determining a true airspeed from an indicated airspeed reading.

1. Reading of airspeed indicator.
2. Instrument error.
3. Pitot position correction.
4. Compressibility correction.
5. Pressure altitude (corrected).
6. Outside air temperature.

Reading of airspeed indicator

Do not expect too great a degree of accuracy in reading the airspeed indicator when operating in rough air. The vibration of the needle and human element will introduce some error. It is believed that, even under the most ideal conditions, figures within plus or minus 2 MPH are the greatest degree of accuracy that can be expected.

After an indicated airspeed reading has been read on the indicator, one would take the figure obtained to a curve for the Airspeed Instrument Calibration to determine the instrument error.

As an example say that 220 MPH was read on the airspeed indicator.

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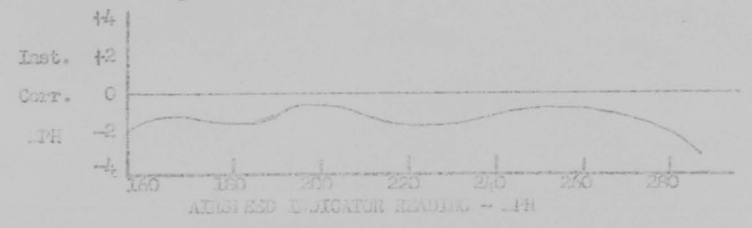
Instrument error

As can be seen by the curve below, the indicated airspeed reading is plotted on the Airspeed Instrument Calibration Curve. Where this indicated airspeed (220) crosses the curve, a line is projected to the axis line showing the correction to add to the instrument reading.



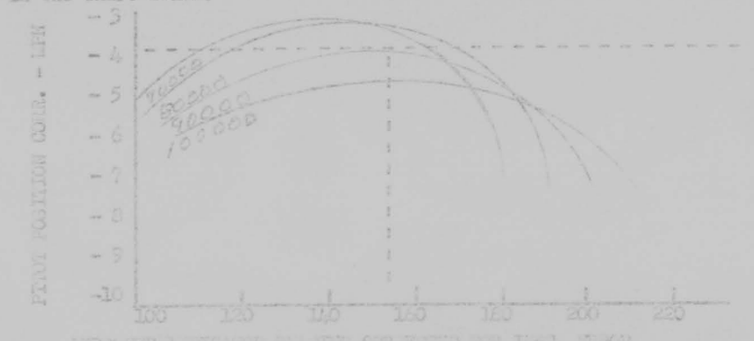

Airspeed Instrument Calibration

After plotting the indicated airspeed instrument reading, it can be seen that the instrument error is minus 1 MPH; therefore, the actual airspeed at this point would now be 219 MPH.

Pitot Position Correction

The next step is to plot the 219 MPH reading on the pitot position correction curves to find the -- MPH (change or correction due only to the position of the pitot head on the airplane for the particular gross weight of the airplane.

Assuming, as an example, the gross weight is 110,000 pounds, enter the $V_I$ - MPH (Instrument reading, corrected for instrument error) side of the curve at 219 MPH until it intersects the gross weight curve as shown in the chart below:



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Pitot Position Correction Curves

From this it can be seen that the pitot position correction is minus 4 MPH. Therefore, the indicated airspeed reading must be again corrected by adding corr= minus 4 MPH to $V_1$ (pilots IAS corrected for instrument error) which will be 215 MPH.

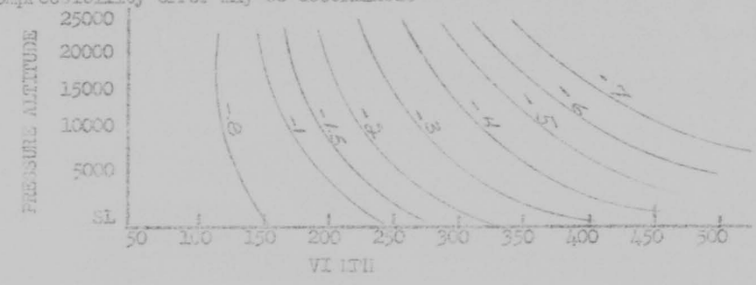
For pitot position correction curves refer to Section V, page 2 of Service Unit Document SUD-1, "Operational Reference Data".

Compressibility Correction

The above reading of 215 MPH indicates a reading free from instrument error and pitot position error; however, the error due to compressibility is yet to be accounted.

A set of curves prepared by the Aerodynamics Department showing compressibility corrections is also included in Service Unit Document SUD-1, "Operational Reference Data", and may be found in Section V, page 3.

Below is shown a compressibility correction curve from which the compressibility error may be determined.




Indicated Airspeed Corrected for Instrument and Pitot Position Errors

The corrected pressure altitude must be determined to solve for the compressibility error.

From reading the altimeter and applying the altimeter instrument correction it is seen that if the pressure altitude is 30,000 ft. and the corrected indicated airspeed reading is 215 MPH, one would enter the chart at 215 MPH until it intersects with the 30,000 ft. pressure altitude line which would give a compressibility correction of approximately minus 4.5 MPH. Therefore subtracting 4.5 MPH from 215 MPH, the result would be 210.5 MPH, which is the TRUE INDICATED AIRSPEED corresponding to the original instrument reading of 215 MPH at 30,000 ft.



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APPENDIX 3 (cont'd)

True Indicated Airspeed Converted to True Airspeed

Now that the true indicated airspeed has been determined the conversion to true airspeed is accomplished by the determination of the air density at the particular altitude at which the original reading of 220 MPH was obtained.

The relationship between true indicated airspeed ($V_1$) and true airspeed (V) is $V_1 = (\sqrt{\sigma})V$ where the $\sigma$ is the ratio of density at altitude to the density at sea level.

In order to determine this airdensity the pilot must rely on his altimeter and air temperature gage.

The altimeter is affected only by its own instrument error which is very minute and may be disregarded for all practical purposes, but the air temperature gage is affected not only by the indicator error, but also upon compressibility.

The effect of compressibility on OAT readings is explained as follows:

Outside Air Temperature

If the outside air temperature was the one read on the gage, it is possible that the error may be as much as 11 degrees.

This is explained by the fact that the air piling up on the bulb compresses itself such that the heat available in a like volume of air being confined in a smaller area has a higher temperature than actual free air at that altitude. It is believed that 80% of the theoretical value due to this air compression around the temperature indicator will account the effect on temperature received. The equation for this again is:

$$T = 0.8 \left(\frac{VI}{100}\right)^2$$

Where: T = Change

I = Temperature in °F

$V_T$ = True Airspeed - MPH

From the above it can be seen that because one is probably calculating or is correctly using the correct OAT found on brake which affects the density altitude.

To determine the correct OAT it is necessary to do the following:

1. Determine the C.A.T. or compressibility correction.



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APPENDIX 3 (cont'd)

2. Use the true OAT thus obtained and the corrected pressure altitude to obtain the density ratio.

3. From this density ratio and the true indicated airspeed (210.5), obtain the true airspeed.

4. If the true airspeed thus obtained, when applied to the formula for correcting OAT for compressibility gives a correction the same as originally assumed, then the assumed temperature compressibility value will be correct.

5. If the original assumed OAT is not correct; assume other values until the calculated values agree.

The true airspeed used in obtaining the compressibility correction is therefore the correct true airspeed.

If the OAT instrument reads a minus 35°C and one assumed that the correct reading should be a minus 41°C value then the OAT would be equal to minus 9°C. Substituting this value in the equation:

$$OAT + Cor_{OAT}\,(Incor.) + Cor_{OAT}\,(Comp.) = OAT\,(True$$

$$-35 + (-2) \qquad + (-9) \qquad = OAT\,(True)$$

$$OAT\,(True) = -46°C$$

Referring to an altitude-temperature chart one finds that a -46°C OAT and a 30,000 pressure altitude the density altitude is approximately 29,300 ft.

Substituting in the equation:

Where:

$\sigma$ = Ratio of density at altitude to the density at sea level

$V\,(True) = V_1 \times \frac{1}{\sqrt{\sigma}}$

$V\,(True) = V_1 \times 1.389$ (from the chart below)

$V_1 = 210.5 \times 1.389 = 343$ kts True Airspeed

A standard altitude chart is shown on the following page.

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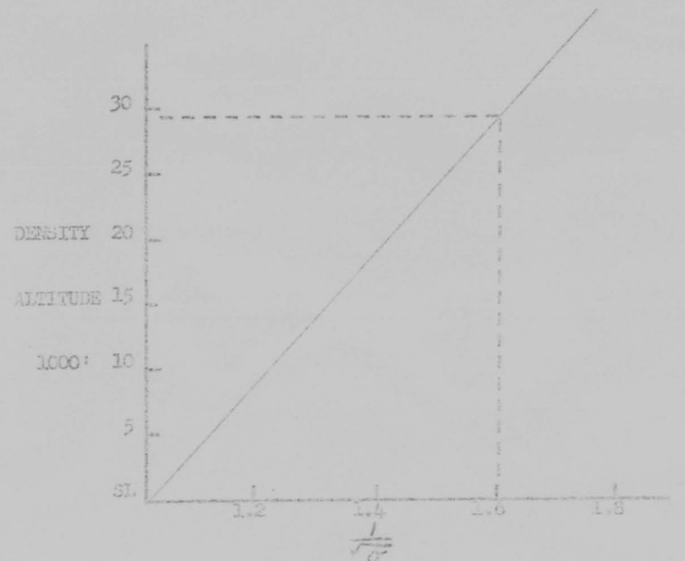


STANDARD ALTITUDE CHART

Substituting in the formula

$$\Delta_T = .8\left(\frac{VT}{100}\right)^2$$

$$\Delta_T = .8\,(3.62)^2$$

$$\Delta_T = 9.39$$

It is therefore seen that the assumed figure of a minus 4.5°C is approximately correct.

Airspeed Calibration

Recent field reports indicate that a great deal of trouble is being encountered in calibrating B-29 airspeed indicators. This is because the calibration is being done by checking ground speed over a short course and using this to get correct indicated airspeed. This method is satisfactory only when done by experienced personnel under ideal weather conditions.



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APPENDIX 3 (cont'd)

Upon investigation it has been found that pilots usually fly a calibrated course in only one direction and presume the wind velocity to be zero. A wind of five or six miles per hour can easily be overlooked, and can introduce an appreciable error in the results obtained. It is therefore suggested that on airspeed calibration runs, the course be flown in both directions and the average of the two ground speeds be taken as the true speed.

Some activities, in an attempt to calibrate airspeed indicators have used a trailing comb to provide a static source for a test indicator.

The trailing static tube calibration method is used by our Flight Research Department and is considered to be very accurate. Hollaran manometers are used to calibrate instrument error.

If a C-1 test set is used to calibrate airspeed indicators on the B-29 airplane, the only error which must be corrected for, that will not show up in the difference in readings between the airplanes airspeed indicator and the C-1's airspeed indicators, is the pitot position error.





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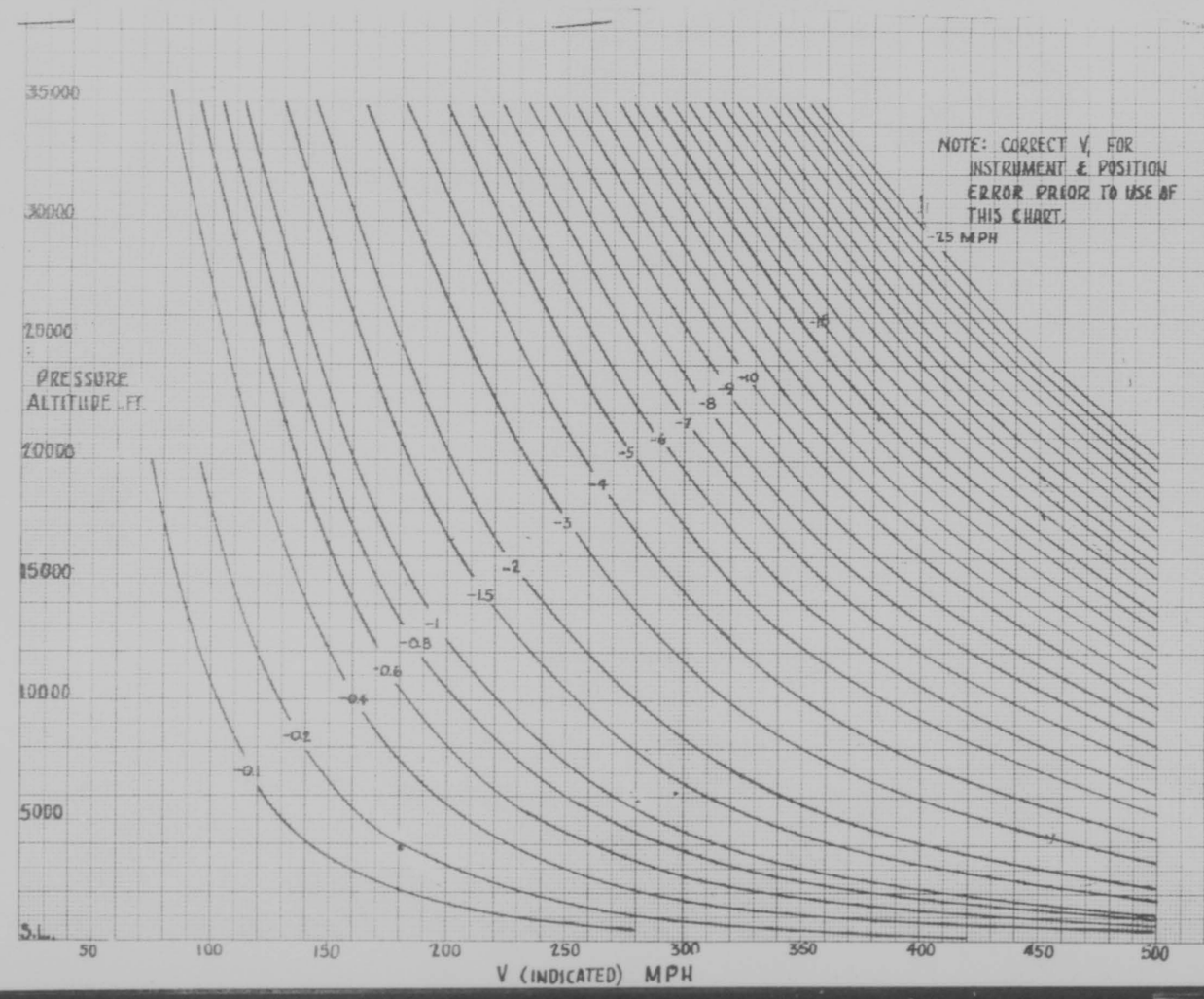


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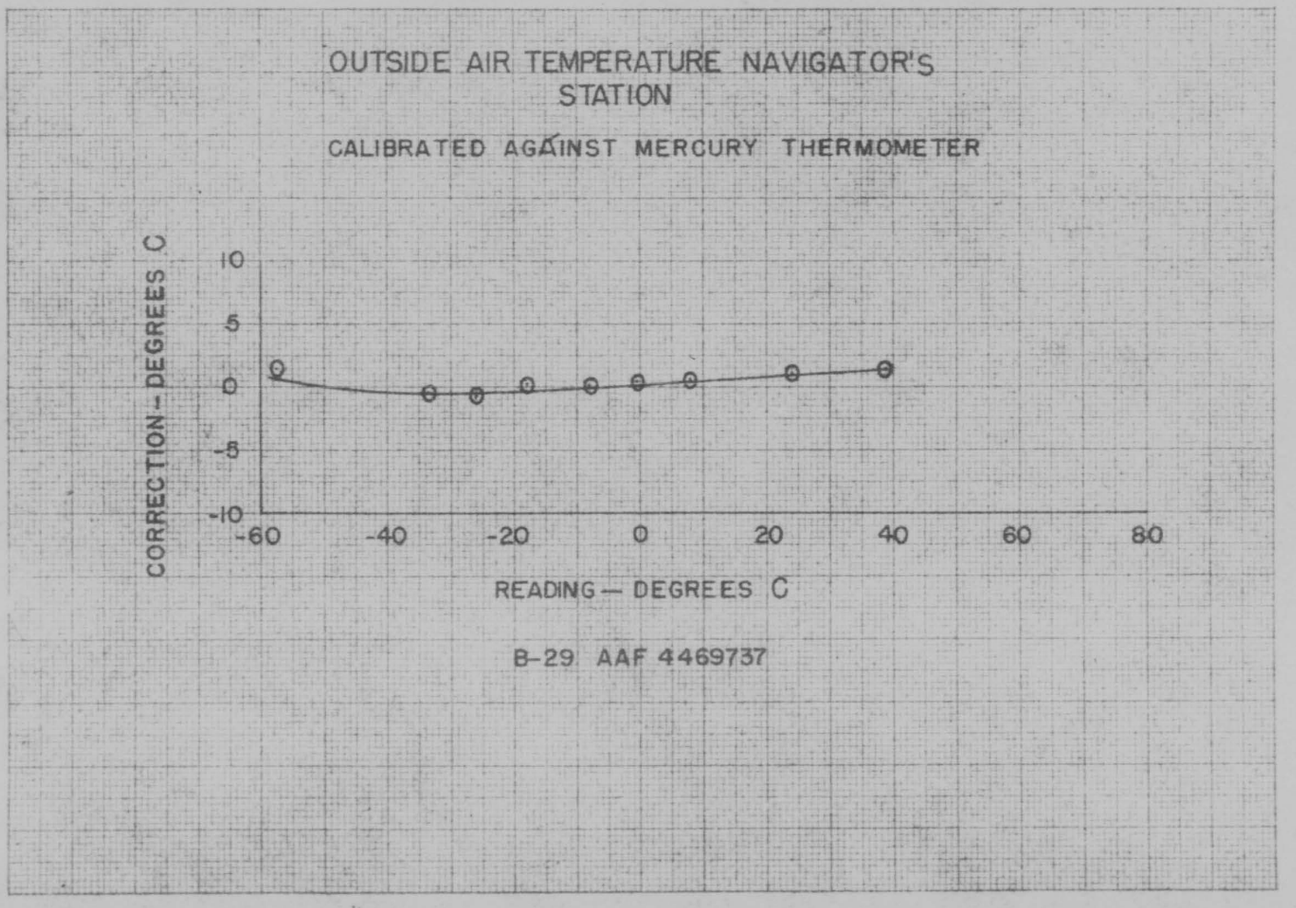




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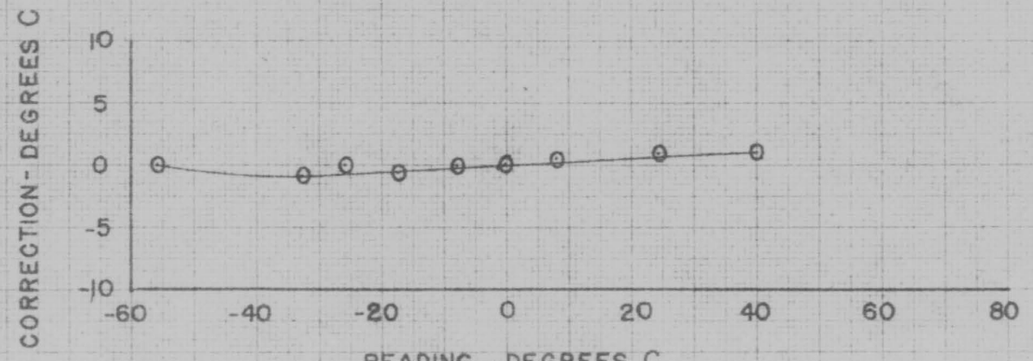
OUTSIDE AIR TEMPERATURE BOMBARDIER'S STATION

CALIBRATED AGAINST MERCURY THERMOMETER

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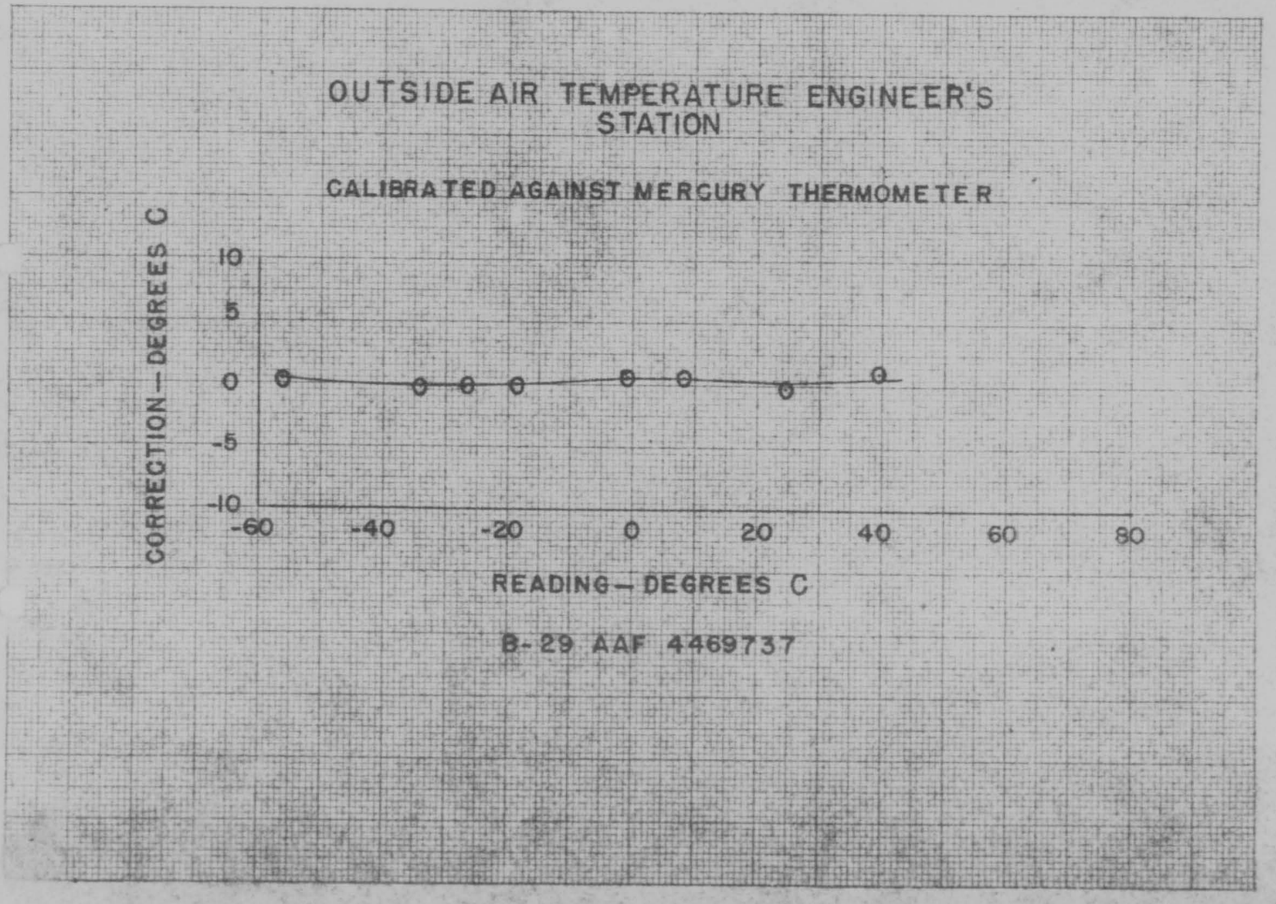




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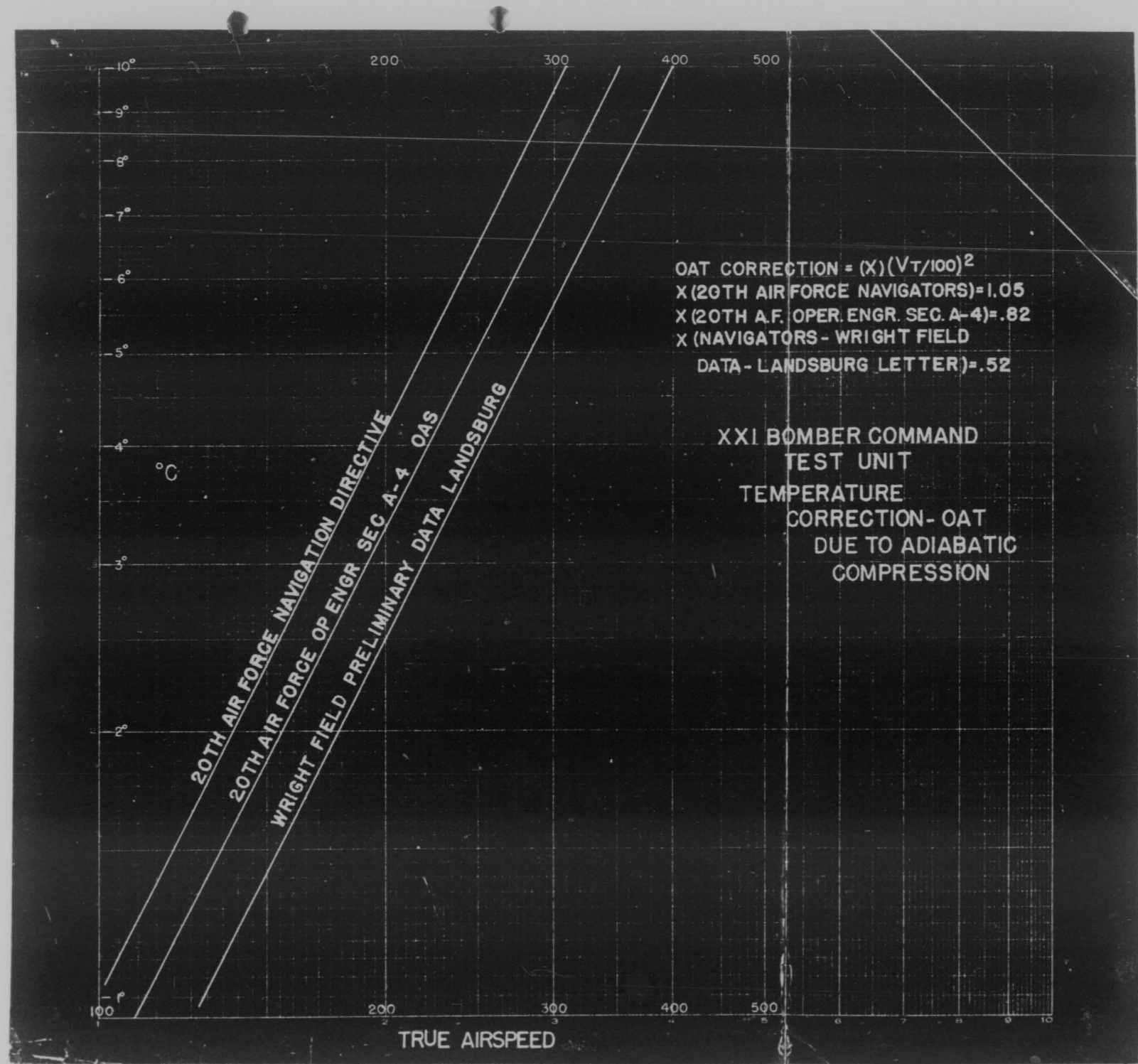


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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By authority of -
C.G., Twentieth Air Force
23 Oct 44
(Date) (Initials)

DIRECTOR OF TWENTIETH AIR FORCE
WASHINGTON AND KHARAGPUR

23 October 1944

| Washington Parties | Kharagpur Parties |
|---|---|
| Lt. Col. Hewitt | Colonel Herman |

Telecon Message No. SUBJECT: Enemy Aircraft and Fighter Tactics

B-065

H. (Talley to Worstell)

Complete report is now given on enemy aircraft and fighter tactics, Mission Number 12.

1. General.

A. 14 of the 24 B-29's participating in the mission were attacked by enemy fighters estimated as 8 Zekes, 5 Oscars, 5 Tojos, 3 Tonys and 1 Nick. Twenty eight attacks were recorded in all, resulting in damage to 2 B-29's. Our preliminary claims list 8 enemy aircraft destroyed and 7 damaged. All of the action occurred in the immediate target areas at altitudes varying from 22,000 to 24,500 feet, and during a 21 minute period from 0415 Z to 0436 Z. Enemy air action is thus rated as weak.

B. All of the 28 attacks took place after bombs had been dropped, and all were single plane encounters, with no coordinated attacks being reported. The enemy made 3 aerial torbing attacks, but no rocket projectiles were observed.

2. Distribution of attacks within formations: The bulk of the attacks (26 out of 28) was made against 1 formation of 13 B-29's. All but 2 of these aircraft were attacked, the exceptions being the No. 3 plane of the "D" element, and the thirteenth plane which was flying to the right and rear of plane No. 2 of the "B" element. The following diagram shows the distribution of attacks against the other 11 aircraft of the formation. The Jap pilots did not single out a particular plane or planes for concentrated attacks, except that No. 3 of "A" element (the highest plane in the formation) and No. 3 of "C" element both experienced 4 encounters whereas the others received 1, 2 and 3 attacks.

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3. Direction and level of attacks: Current Jap tactics of attacking B-29's frontally were continued in Mission Number 12 with 50 percent of the attacks originating at 11, 12, or 1 o'clock. 21.5 percent came from the right side, 21.5 percent from the rear, and 7 percent from the left side. 40 percent of the total originated high, 32 percent low and 28 percent level. However, of the 14 attacks against the front quarter, 6 were low, 4 were level and 4 high. This indicates a change from tactics of the last 3 missions, where the majority of the frontal attacks were high. Details of direction and level of approach are shown in Tables No. 1 and No. 2.

TABLE NO. 1 - DIRECTION AND LEVEL OF APPROACH

| DIRECTION OF ATTACK OR PASS | LEFT SIDE | | | FRONT | | | RIGHT SIDE | | | REAR | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| HIGH | | | | 2 | | 2 | 2 | | 1 | 1 | 2 | 1 | 11(39PC) |
| LEVEL | | | 1 | 1 | 3 | | 2 | | | | 1 | | 8(29PC) |
| LOW | 1 | | | 2 | 1 | 3 | | 1 | | | 1 | | 9(32PC) |
| TOTAL | 1 | | 1 | 5 | 4 | 5 | 4 | 1 | 1 | 1 | 4 | 1 | 28 |
| | (2) | | | (14) | | | (6) | | | (6) | | | |

TABLE NO. 2 - LEVEL OF APPROACH

| LEVEL OF APPROACH | LEFT SIDE | FRONT | RIGHT SIDE | REAR |
|---|---|---|---|---|
| HIGH | 0 | 4 | 3 | 4 |
| LEVEL | 1 | 4 | 2 | 1 |
| LOW | 1 | 6 | 1 | 1 |
| TOTAL (ATTACKS) | 2 | 14 | 6 | 6 |

4. Exchange of fire: Jap pilots opened fire in 75 percent of the encounters, as compared to 50 percent in Mission Number 11, 52 percent in Mission Number 9, 39 percent in Mission Number 8 and 72 percent in the case of Mission Number 7. The tendency was to open fire at closer ranges than in previous missions. B-29's fired in 75 percent of the encounters and as in the past, continued to open fire at long ranges. Distances at which B-29's and enemy aircraft opened fire are shown in Table No. 3.

TABLE NO. 3 - DISTANCE OPENED FIRE

| DISTANCE (YARDS) | ENEMY FIRE | B-29 FIRE |
|---|---|---|
| 0-500 | 27 percent | 21 percent |
| 500-800 | 38 percent | 21 percent |
| 800-1000 | 5 percent | 15 percent |
| 1,000 & Over | 30 percent | 43 percent |

5. Aggressiveness of enemy attacks: Enemy pilots showed a greater degree of aggressiveness than in any previous mission with 75 percent, or 21, of the attacks being pressed to 250 yards or less. Many attacks were described as terminating in dives through the formation. Flying skill of the fighter pilots is rated high, but their gunnery at best was poor. Distances to which attacks were closed are shown in Table No. 4.

TABLE NO. 4 - DISTANCES TO WHICH ATTACKS WERE PUSHED

| DISTANCE (YARDS) | ENCOUNTERS | PERCENTAGE |
|---|---|---|
| 1000 & Over | 3 | 11 |
| 800-1000 | 0 | 0 |
| 500-800 | 3 | 11 |
| 250-500 | 1 | 3 |
| 25-250 | 21 | 75 |
| TOTAL | 28 | 100 Percent |



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6. Breakaways: Usual Jap breakaway tactics were employed, with dives, splits, S's and banks predominating, sharp dives being used most often.

7. Coordinated attacks: No coordinated attacks were observed.

8. Aerial bombing attacks: The enemy made 3 aerial bombing attacks, all employing phosphorous bombs, none of which damaged any of our aircraft. One enemy plane approached from 2 o'clock high and released a bomb when about 1,000 yards above the formation. The bomb exploded 500 feet above and 200 feet to the left. Another fighter approaching from 2 o'clock high released a bomb while in a dive. The bomb exploded wide of its mark, and the Jap continued his dive through the formation, firing with machine guns, the third attack occurred when an Oscar approached high from 7 o'clock. The bomb was released while in a dive 200 yards above the formation, and burst 100 yards to the left and 50 feet above. Again, the enemy plane continued its dive through the formation but in this instance did not open fire with machine guns.

9. New weapons and tactics: None reported.

10. Evasive action by B-29's: None reported.

11. Summary

A. Air opposition rated as weak.

B. No B-29's destroyed, 2 damaged as a result of enemy air action. Our preliminary claims are 8- C- 7.

C. All attacks occurred in the immediate target areas, and all after "Bombs Away". Action confined to a 21 minute period.

D. Most attacks originated from the front quarter, low.

E. Enemy opened fire in 78 percent of the encounters, B-29's in 75 percent. Enemy opened fire at closer ranges than in recent missions.

F. Seventy five percent of enemy attacks pressed to 250 yards or less.

G. Dive the most common breakaway.

H. No particular formation position singled out for attack.

I. No coordinated attacks.

J. 3 phosphorous bomb attacks.

K. No evasive action by B-29's.

12. Enemy Aircraft Markings:

| COLOR | PLANE | MARKINGS |
|---|---|---|
| Dark green | Zeke | No marking observed. |
| | Zeke | 4 stripes on left wing. |
| Black | Tony | No marking observed. |



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| COLOR | PLANE | MARKINGS |
|---|---|---|
| Grey | Zeke 32 | No markings observed. |
| | Zeke | No markings observed. |
| Unreported | Tony | Red ball on fuselage and bottom of both wings. |
| | Zekes | Red ball on fuselage and bottom of both wings. |
| | Tojos | Red ball on wing; orange belly. |
| | Oscar | Red ball on wing; orange belly. |
| | Oscar | Red sun with white circle on wings. |
| | Oscar | Dark red circle under left wing. |

That is all we have

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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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By authority of -
C.G., Twentieth Air Force
23 Oct 44 (MJH)
(Date) (Initials)

EXTRACT OF TELETYPE CONFERENCE BETWEEN WASHINGTON AND KHARAGPUR

| Washington Parties | Kharagpur Parties |
|---|---|
| Lt. Col. Hewitt | Colonel Herman |

Telecon Message No. D-064

SUBJECT: Enemy Aircraft and Fighter Tactics

K: (LeMay to Norstad)

Complete report is now given on enemy aircraft and fighter tactics, Mission Number 11.

1. General.

A. Enemy fighter reaction was weak with 26 B-29's being attacked by an estimated 15 Tojos, 8 Zekes, 5 Oscars, 5 Tonys and a few unidentified aircraft which waged a total of 51 attacks. Two B-29's sustained damage in these encounters while our preliminary claims list 3 enemy aircraft destroyed, 3 probably destroyed and 9 damaged.

B. Forty-seven of the attacks occurred in the immediate areas of the targets and four took place out over the Formosa Strait. The action was confined to a 39 minute period, from 0406Z to 0445Z, and took place at altitudes varying from 19,000 to 26,000 feet. Three attacks were encountered before "bombs away," and 48 after bombs had been dropped, indicating that the Jap was not set for the B-29's.

C. The enemy employed aerial bombs and rockets as well as normal pursuit tactics. Only one coordinated attack was reported; although other instances were recorded of attacks being waged at almost the same time, it appeared to our crews that they were coincidental rather than coordinated.

2. Direction and level of attacks.

A. Japanese pilots again made the bulk of their approaches from the front quarter with 54 percent of all attacks originating at 11, 12 or 1 o'clock. Twenty-three percent came from the right side, 21 percent from the rear and only 2 percent from the left side. This distribution indicates a greater proportion of frontal attacks than in recent missions when compared to 42 percent front approaches in Mission No. 9 and 40 percent in Mission No. 8. The preference for the frontal approach has been prevalent in all recent daylight missions, and can be accepted as a Japanese tactical characteristic in attacks on B-29's. The relative absence of encounters against the left side, and the increase in number of attacks from the rear are believed to have been caused by the Jap preference to attack out of the sun.

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B. As in Mission No. 9, the majority of attacks originated high. Fifty-six percent came from above, with 40 percent low and 4 percent level. Mission No. 9 marked the turning point from a preponderance of low attacks to a preponderance of high attacks, and as the same reaction was noted in Mission No. 11, a trend in Jap tactics may be indicated. It is of particular interest that the attacks originating from the front quarter (11, 12 and 1 o'clock) were predominantly high. Details of direction and level of approach are shown in Tables No. 1 and No. 2.

Table No. 1 - Direction and level of approach.

| | Left Side | | | Front | | | Right Side | | | Rear | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction of Attack or Pass | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| High | | | | 9 | 8 | 2 | 4 | 1 | | 2 | 1 | 1 | 28(54PC |
| Level | | | | 1 | | 1 | | | | | | 1 | 3(6PC |
| Low | 1 | | | 3 | 2 | 2 | 5 | 1 | 1 | 3 | | 3 | 21(40PC |
| Total | 1 | | | 13 | 10 | 5 | 9 | 2 | 1 | 5 | 2 | 4 | |
| | 1 (2PC | | | 28/54PC | | | 12(23PC | | | 11/21PC | | | 52 |

Table No. 2 - Level of approach.

| Level of Approach | Left Side | Front | Right Side | Rear |
|---|---|---|---|---|
| High | 0 | 68 PC | 42 PC | 36 PC |
| Level | 0 | 7 PC | 0 | 9 PC |
| Low | 1 attack | 25 PC | 58 PC | 55 PC |

3. Exchange of fire: Enemy aircraft opened fire in 50 percent of the attacks, which is a normal percentage and compares closely with enemy fire in the last 3 missions. In 36 percent of the attacks in which fire was experienced, Jap pilots opened fire at ranges of 1000 yards or greater. This tendency to begin the attack at long ranges was noted in Mission No. 9 also. B-29's opened fire in all except 2 of the 52 encounters, a higher percentage of fire than in any previous mission. Our aircraft too fired at long ranges, opening fire at 1000 yards or more in 60 percent of the attacks. A comparison of the distances at which enemy aircraft and B-29's opened fire is shown in Table No. 3.

Table No. 3 - Distances Opened Fire

| Distance (yards) | Enemy Fire | B-29 Fire |
|---|---|---|
| 0 - 500 | 3 PC | 6 PC |
| 500 - 800 | 31 PC | 14 PC |
| 800 - 1000 | 30 PC | 20 PC |
| 1000 & over | 36 PC | 60 PC |

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4. Aggressiveness of enemy attacks: Enemy pilots were aggressive, with 40 percent of all attacks being pressed to 250 yards or less. Eleven attacks were reported as closing to 50 yards, and 2 to a distance of 25 yards. The closely pressed attacks often terminated in dives through the formation. Distances to which attacks were closed are shown in Table No. 4. It is of interest to note that the percentages duplicate almost exactly the figures from the same analysis, Mission No. 9. In these two instances at least, the aggressiveness of the Jap Army Pilots at Anshan was comparable to the aggressiveness of a combination of Army and Navy Pilots over Formosa.

Table No. 4 - Distances to which attacks were closed.

| Distance (yards) | Encounters | Percentage |
|---|---|---|
| 1000 & over | 5 | 10 |
| 800 - 1000 | 8 | 16 |
| 500 - 800 | 7 | 14 |
| 250 - 500 | 10 | 20 |
| 15 - 250 | 21 | 40 |
| | 51" | 100 percent |

" 1 encounter not included - incomplete data.

5. Breakaway manouvers: As in the case of previous missions, the enemy employed a number of breakaways with the dive being used most often. Splits's, banks, half rolls and chandelles were also seen.

6. Attacks against formation positions: A plotting of the attacks against formations reveals that the enemy did not concentrate on any particular position or positions. Lead, wing and inside planes were all attacked, and the distribution was haphazard.

7. Coordinated attack: In the only coordinated attack reported, 2 Oscars approached simultaneously, 1 from 11 o'clock high and the other from 12 high. Both opened fire at 1000 yards, the Oscar from 11 crossing over to 1 o'clock and then pressing the attack to 200 yards at which point he was hit by the Bombardier and went out at 4 o'clock in flames. This plane is claimed as destroyed. The other Oscar pressed his attack to 100 yards and dived, going out low at 6 o'clock. These tactics are typical of the single plane encounters also. Approach made from the frontal quarter high, fire opened at fairly long range, attack pressed to within 250 yards and terminating in a dive.

8. Aerial bombing attacks.

A. A total of 9 aerial bombing attacks was reported. Approach was usually made from the front quarter (11, 12 or 1 o'clock) with the bomb being released at 250-300 yards while the enemy fighter was in level flight. One exception to these tactics was noted when a Tojo flew over the formation from the rear, performed a split S and released a bomb apparently aimed at the formation leader. Aiming was poor, and none of the aerial bombing attacks resulted in damage to B-29's.

B. Bombs were of the phosphorous type with snow white bursts (some were reported as red in the center) spreading tentacles about 50 feet wide and 100 feet deep. One burst, viewed at considerable distance, appeared to be much larger than the normal phosphorous burst, and may indicate that the Japanese have developed a new bomb. It appeared that several of the bombs were supported by parachutes.



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C. Two observations were unusual in that the bombs appeared to explode immediately after release. A Tony pulled ahead of the formation turned and approached from 12 o'clock. When about 1500 yards from the formation, the fighter broke into an abrupt dive. Immediately afterward, a large patch of white smoke, with streamers, appeared in the sky at the exact spot where the Tony had begun his dive. In the other instance, a ball of white smoke with streamers suddenly appeared immediately astern of a Tony and seemed to have been ejected from the tail of the fuselage. Tony had been pacing the formation out of range on the right beam.

9. Rocket attacks.

A. An Oscar approached from 5 o'clock low and was first sighted at 1200 yards. When about 1000 yards out, the fighter fired a rocket. The tail gunner saw the projectile for a split second and described it as having a red tail. It exploded with a red and yellow flash mixed with white smoke and then emitted white streamers. The explosion occurred 100 feet behind, 100 feet below and 200 yards to the right. The tail gunner opened fire at about the time the projectile was released, and the Oscar is claimed as destroyed.

B. Another B-29 reported a Tojo which fired 5 rockets, 3 in one burst and 2 in another. The fighter approached from 2 o'clock high and when 1000 yards out, was about 1000 feet above the B-29. The fighter drifted back as he closed the attack, and was 400 yards out and 200 feet above when the first rockets were released. Two projectiles came from under 1 wing and 1 from under the other wing. Seconds later, 2 additional rockets were released. The trajectory was flat; the trail and ensuing burst were white.

10. Possible new weapons.

A. One B-29 enroute to the target when 60 miles out from the China coast made observations of a possible new weapon. Trails of black smoke were seen to hang at altitude, and then explosions of white phosphorous streamers. Three trails were seen, two traveling together. No enemy aircraft were sighted, and there were no vessels in the Formosa Strait. These observations may be related to previous reports of remotely controlled rockets.

B. Another crew observed a small black dot in the air at 25,000 feet above the coast of Formosa just west of Okayama. The dot seemed to hang in the air without any movement or explosion, and remained stationary while in vision of the crew. It appeared to be smaller than a flak burst, and to have the appearance of an object rather than a cloud of smoke or burst from an explosion.

C. An Oscar was reported as being armed with 4 cannons in the wings. Plane may have been Jack.

11. Evasive action: The lead plane of one formation employed slight turns after "bombs away," maintaining constant speed and altitude. This was the only instance of B-29 evasive tactics reported.

12. Summary.

A. Enemy air opposition rated as weak.

B. No B-29's destroyed, 2 damaged as a result of enemy air action. One preliminary claims are 3, 3 and 9.



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C. Most of the attacks occurred in the target areas, after "bombs away." Action confined to a 39 minute period.

D. Most attacks originated high from the frontal quarter.

E. Enemy opened fire in 50 percent of encounters. B-29's opened fire in all except two of the attacks. Much of the firing on both sides was done at long ranges.

F. Forty percent of enemy attacks pressed to 250 yards or less.

G. Most breakaways ended in dives.

H. No particular formation position singled out for attack.

I. Only 1 coordinated attack.

J. Nine aerial bombing attacks. Bombs were of the phosphorous type.

K. Two air-to-air rocket attacks.

L. Two instances of possible remote control rockets.

M. Very little evasive action by B-29's.

13. Enemy aircraft markings:

| Color | Aircraft | Markings |
|---|---|---|
| Black | Tojo | Red markings, |
| | Oscars | Yellow stripes, Red dot. |
| Silver | Tojos | No markings observed. |
| | Zekes | No markings observed. |
| Grey | Tojos | No markings observed. |
| | Zekes | No markings observed. |
| | Tony | No markings observed. |
| Olive-Drab | Tojo | No markings observed. |
| | Zekes | 2 Red stripes on Tail, 1 Red Stripe on Fuselage. |
| | Tonys | Red Balls on Wings and Fuselage. |
| | Oscars | No markings observed. |
| Dark Green Camouflaged Brown | Zekes | No markings observed. |
| | Tojos | No markings observed. |
| Brown and Orange | S/E | Red Balls on Wings. |
| Olive-Drab | Tojo | Red Balls on Wings. |
| | Oscar | No markings observed. |
| | Tonys | Rising Sun on Top of Wings and on Fuselage behind the Canopy. |
| Brown and Black | Oscars | Stripes diagonally across Fin and Rudder and Tail End of Fuselage; Red Balls Inside Yellow Rings on Both Sides of Wings. |
| Unreported | Oyiar | Red Circles on Top of Wings; Light Blue Stripe Back of Cockpit where Trailing Edge of Wing Enters Fuselage. |
| | Tojos | 3 Yellow Stripes around Fuselage. |
| | Tojo | Red Ring around Fuselage close to Tail. |
| | Tojos | Red Circles on each Wing. |

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HEADQUARTERS TWENTIETH AIR FORCE

Washington D. C.

PRACTICE MISSION REPORT OF THE XXI BOMBER COMMAND

27 OCTOBER 1944

Targets: Dublon Island, Truk

Take-off: From Saipan

Time of Attack: 272350 - 272358 East Longitude Time
(271450Z - 271458Z)

Aircraft: Airborne 18
Total Bombing 14
Early Returns 4

Missing: None

Casualties: None (1 CFC gunner badly cut on head when blister blew out)

Bomb Load: 20 - 500 lb. GP per aircraft

Tactics: Daylight visual bombing in formation from 25,000 feet.

Weather: Excellent visibility

Fighter Opposition: Nil

Flak: Moderate, accurate but 5,000 feet below formation.

Fighter Support: None

Claims: None

Results: Good to Poor by visual observation.

Misc.: Some possible fuel fires by visual observation. Two single engine fighters seen over target, probable Zeke's. Three very small ships seen off Dublon Island shore. Approximately 7 small ships in harbor, some probably flak ships.

As of 1500, 28 October 1944

LAURIS NORSTAD
Brigadier General, U. S. Army
Chief of Staff

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HEADQUARTERS FIFTEENTH AIR FORCE

Washington, D. C.

PRELIMINARY PHOTO RECONNAISSANCE MISSION REPORT NO. AIR-12
ON MISSION NO. 12 - 17 OCTOBER

Take-Off:

Aircraft No. 288 took off from Pinching at 0710 China Time (2310Z) 16 October and landed at Hsinching at 1850 China Time (1050Z) 17 October.

Photo Coverage Obtained:

1. Hako Island (23° 33' N - 119° 39' E) was overcast and no photos obtained.
2. Shinchiku Airfield (24° 50' N - 120° 53' E) clear - photos taken.
3. Taihoku Airfields (25° 03' N - 121° 30' E) clear - photos taken.
4. Kizun (25° 33' N - 121° 44' E) overcast; no photos taken.
5. Giran (24° 56' N - 121° 45' E) clear - photos taken.
6. Taichu (24° 08' N - 120° 43' E) 5/10 cloud - photo coverage unknown.
7. Kagi (23° 27' N - 120° 26' E) 5/10 cloud - photo coverage unknown.
8. Tainan (23° 00' N - 120° 10' E) 10/10 cloud - no photos taken.
9. Takao (22° 37' N - 120° 17' E) 5/10 cloud - photo coverage unknown.
10. Tainchu (24° 09' N - 120° 42' E) 10/10 cloud - no photos taken.
11. Heito Airfield (22° 40' N - 120° 16' E) - very good quality photos taken.

Enemy Opposition:

No enemy aircraft encountered.
AA meager and inaccurate at Okayama.
Visual Observations

Visual Observations:

9 oil storage tanks seen on China Coast at 24° 25' N - 118° 04' E.
20 small vessels were observed at Takao.
Takao Harbor observed to be covered with oil.

Results:

Kinansho - cloud covered.
Okayama - Photos reveal that Assembly Plant was destroyed with only 4 small buildings escaping destruction or heavy damage.
Takao - 475-foot tanker suffered one direct hit and additional damage by 2 near misses. Direct hit or near miss damaged a 460-foot cargo vessel and a short distance North, a near miss may have damaged a 485-foot tanker. Near misses may have also damaged a 200-foot coastal vessel. On the main pier, a large warehouse was hit, and a dredging line in the harbor is broken. In the Marshalling yard, one hit is observed near the choke point.

Supplementary Information on Missing Aircraft of Missions 10 - 11 - 12

Mission No. 10

Aircraft 515 of the 40th Group reported to have crashed near Changtey, but Pilot reported all crew members to be safe.

Aircraft 280 of the 444th Group believed to have exploded some 200 miles South of Chengtu.

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Aircraft 256 of 468th Group landed at Suichwan needing gas. Gas has already been dispatched.

Mission No. 11

Aircraft 307 of the 444th Group landed at Hanyung needing parts. These were dispatched yesterday.

Aircraft 265 of the 468th Group landed at Childiang and help has been sent.

Mission No. 12

Aircraft 324 of the 40th Group crashed after take-off - 2 killed.
Aircraft 295 of the 40th Group landed at Ichow and expects to return to home base today.
Aircraft 466 of the 40th Group landed at Suichwan needing gasoline.

HARRIS HOUSTAD,
Brigadier General, U. S. Army
Chief of Staff

As of 1100 - 18 October 1944

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17 Oct. 1944

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HEADQUARTERS TWENTIETH AIR FORCE

Washington, D. C.

# PRELIMINARY MISSION REPORT OF XX BOMBER COMMAND

## OPERATION NO. 12 - 17 OCTOBER 1944

**Targets:** Primary - Einansho Airdrome
Secondary - Port of Takao
Tertiary - Coastal Ports in China and Formosa
Last Resort - Hengyang

**Take-off:** From Chengtu Bases 0657 to 0736 China Time (2257Z to 2336Z)

**Time of Attack:** Over Primary Target 1312 to 1316 Japanese Time (0412Z to 0416Z)
Secondary Target 1322 to 1327 Japanese Time (0422Z to 0427Z)

**Aircraft:**

| | | |
|---|---|---|
| Airborne | | 30 |
| Total Bombing | | 24 |
| *Einansho | 10 | |
| *Takao | 13 | |
| Other Target | 1 | |
| Early Returns | | 6 |

* First formation bombed secondary target (Takao) which was CAVU because at that time large clouds obscured primary (Einansho). Second and third formations which bombed primary found coverage there had diminished to 2/10 to 5/10 and 25 miles visibility.

**Time of Landing:** All aircraft but one returned by 0956Z. 1 aircraft missing but reported heading for Suichuan.

**Losses:** 1 missing

**Casualties:** 2 killed, 3 wounded, 11 missing

**Total Bomb Tons Dropped:** Approximately 147.75

**Tactics:** Daylight visual bombing at altitude of 24,000 feet.

**Weather:** Primary Target - CAVU to 7/10 depending on position of big cloud.
Secondary Target - CAVU

**Enemy Opposition:**
Fighter Opposition: Primary Target - Moderate
Secondary Target - Considerable Phosphorus bombing
Anti-Aircraft Fire: Primary Target - Meager and inaccurate
Secondary Target - Meager to moderate and accurate.
Observations: Five high altitude balloons at 23,000 feet presumably at primary but not definitely reported as to location.

**Claims:**

| | |
|---|---|
| Destroyed | 7 |
| Probably Destroyed | 0 |
| Damaged | 8 |

**Results:** Not reported yet.

**Misc.:** 1 heavy cruiser and 10 small merchant vessels visually sighted in Amoy Harbor at 1300Z.

**Remarks:** This report is an yet fragmentary, and is not to be used for official records as it is subject to change.

Report as of 1700 - 17 October

LAURIS NORSTAD
Brigadier General, U. S. Army
Chief of Staff

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HEADQUARTERS TWENTIETH AIR FORCE
Office of the Commanding General
Washington 25, D. C.

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By authority of -
C.G., Twentieth Air Force
6 Nov 1944 (Date) (Initials)

EXTRACT OF TELETYPE CONFERENCE BETWEEN WASHINGTON AND KHARAGPUR

Washington Parties: Colonel Hewitt

Terminal Parties: Colonel Herman

Telecon Message No: D-974

Subject: Enemy Tactics, Mission 13

---

K: (From LeMay to Norstad)

Following is report of enemy tactics for Mission 13.

1 - Enemy air opposition
Mission No. 13
25 October 1944

A. General:

1. Forty-three of the B-29's participating in the mission were attacked by enemy fighters and air opposition is rated as moderate. Enemy waged 102 single and coordinated attack resulting in 120 individual encounters. One B-29 crashed subsequently probably as a result of these attacks and 12 were damaged, while B-29 crews claim 7 enemy aircraft destroyed, 5 probably destroyed and 18 damaged. It is estimated that the mission was intercepted by 43 - 50 fighters consisting of 15 - 18 Tojo, 10 - 12 Tony, 8 - 10 Zeke, 4 Oscar, 2 new T/E fighters, 52 Nick, 1 Pete and 1 Nate. This is the first report of the Japanese using obsolete fighters in combat against B-29's. The Nate is claimed as destroyed.

2. Fighter attacks occurred on the route to the target, in the target area, and on the route back to base, but were concentrated at the primary target and in the Saishu Island area on the route back. Of the 120 encounters 105 were met in these two areas, and 111, or 92.5 per cent of the encounters occurred after bombs had been dropped, indicating either that the Jap warning net did not function efficiently or that fighter forces were poorly deployed.

3. The first attack occurred in the Nanyang area at 2040Z in the hours of darkness; the enemy plane was not sighted and the attack was evidenced only tracer bullets. Four attacks were experienced over the Yellow Sea, 2 en route to the target and 2 on the route back. Ten



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encounters occurred in the Nanking area on the route back to base. Details of all encounters are shown in Table No. 1, giving locations, number of encounters, type of fighter, time and altitude.

TABLE NO. 1 - DETAILS OF ENCOUNTERS

| LOCATION | NO. ENCOUNTERS | TYPE E/A | TIME | ALTITUDE (IN FEET) |
|---|---|---|---|---|
| ROUTE TO TARGET: | | | | |
| Nanyang | 1 | Not Seen | 2040Z to 0104Z | 15,000 |
| Yellow Sea | 2 | 2 Tony | 0104Z to 0104Z | 23,000 |
| Primary Target | 80 | 32 by Tojo | 0051Z to 0124Z | 21,000 to 26,000 |
| | | 15 by Zeke | | |
| | | 13 by Oscar | | |
| | | 11 by Tony | | |
| | | 3 by T/E | | |
| | | 2 by Nick | | |
| | | 2 by Pete | | |
| | | 1 by Nate | | |
| | | 1 by S/E | | |
| ROUTE BACK: | | | | |
| Saishu Island | 25 | 18 by Tony | 0124Z to 0311Z | 15,000 to 23,000 |
| | | 6 by Tojo | | |
| | | 1 by Nick | | |
| Yellow Sea | 2 | 1 by Zeke | 0103Z | 22,000 |
| | | 1 by Nick | 0235Z | 23,000 |
| Nanking Area | 10 | 5 by Zeke | 0350Z to 0542Z | 14,800 to 24,000 |
| | | 2 by Tony | | |
| | | 2 by S/E | | |
| | | 1 by Oscar | | |

B. Distribution of attacks within the formation:

1. As in the case of previous missions, there was no decided concentration of attacks on any particular formation positions, and the distribution of attacks was irregular and haphazard. However, there was a slight tendency to concentrate attacks on the No. 4 position of 4-plane formations, and on the No. 3 plane of 'B' element, (the highest plane) in the larger formations.

C. Direction and level of attacks:

1. The enemy continued to indicate a preference for the frontal approach as in the case of previous missions. Forty-three per cent of the attacks originated from the front quarter, 21 per cent from the right side, 21 percent from the rear, and 16 per cent from the left side. This is approximately the same distribution of attacks as encountered in the last 3 missions.





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2. As to level of approach, 40 per cent were high, 40 per cent low, and 20 per cent level. This indicates a change in Jap tactics from the last three missions in which the preponderance of attacks was high. Details of direction and level of approach are shown in Table No. 2. Aerial bombing attacks have been eliminated from this analysis.

TABLE NO. 2 - DIRECTION AND LEVEL OF APPROACH

| LEVEL OF ATTACK OR PASS | LEFT | FRONT | RIGHT | REAR | TOTALS |
|---|---|---|---|---|---|
| | 8 9 10 | 11 12 1 | 2 3 4 | 5 6 7 | |
| High | 0 0 6 | 11 10 4 | 7 1 0 | 2 1 1 | 43 (40PC) |
| Level | 3 2 0 | 3 4 1 | 1 1 0 | 1 4 1 | 21 (20PC) |
| Low | 2 0 3 | 7 3 3 | 2 3 7 | 4 4 4 | 42 (40 PC) |
| | 5 2 9 | 21 17 8 | 10 5 7 | 7 9 6 | |
| Totals | 16 (15 Percent) | 46 (43 Percent) | 22 (21 Percent) | 22 (21 Percent) | 106 |

3. Analysis of the level of approach within the 4 direction quarters (left, front, right and rear) reveals the data shown in Table No. 3. It is note worthy that 54 per cent of the front attacks came from above, whereas the majority of the right side and rear attacks came from below.

TABLE NO. 3 - LEVEL OF APPROACH

| LEVEL OF APPROACH | LEFT SIDE | FRONT | RIGHT SIDE | REAR |
|---|---|---|---|---|
| High | 38 Percent | 54 Percent | 36 Percent | 18 Percent |
| Level | 31 Percent | 17 Percent | 9 Percent | 27 Percent |
| Low | 31 Percent | 29 Percent | 55 Percent | 55 Percent |
| | 100 Percent | 100 Percent | 100 Percent | 100 Percent |

4. A change is noted in the direction of aerial bom bing approaches. Whereas in previous missions they came almost entirely from 11, 12, or 1 o'clock, front, beam and stern attacks were encountered in Mission No. 13. Details are shown in Table No. 4.

TABLE NO. 4 - DIRECTION OF AERIAL BOMBING ATTACKS

| LEVEL OF ATTACK OR PASS | LEFT SIDE 8 | 9 | 10 | FRONT 11 | 12 | 1 | RIGHT SIDE 2 | 3 | 4 | REAR 5 | 6 | 7 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| High | 0 | 2 | 0 | 0 | 2 | 3 | 2 | 2 | 0 | 0 | 2 | 1 | 14 |

D. EXCHANGE OF FIRE:

1. Enemy pilots opened fire in 68 per cent of the encounters (aerial bombing attacks not included) as compared to 78 per cent fire in Mission No. 12 and 50 per cent in Mission No. 11. In 44 per cent of the attacks, the enemy opened fire at ranges of 1,000 yards and over, A greater percentage for this range than in either mission No. 11 or 12. B-29's opened fire in 92 per cent of the encounters, a normal percentage for recent missions. Our A/C fired at ranges of 1,000 yards



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or more in 53 per cent of the attacks, details of distances at which fire was opened are shown in Table No. 5.

TABLE NO. 5 - DISTANCES OPENED FIRE

| DISTANCES (YARDS) | ENEMY FIRE | B-29 FIRE |
|---|---|---|
| 0 - 500 | 8 Per Cent | 6 Per Cent |
| 500 - 800 | 32 Per Cent | 18 Per Cent |
| 800 - 1000 | 16 Per Cent | 23 Per Cent |
| 1000 - Over | 44 Per Cent | 53 Per Cent |

E. AGGRESSIVENESS OF ENEMY ATTACKS:

1. Aggressiveness of enemy attacks was similar to that experienced in Mission No. 9 in which more closely pressed attacks were encountered than in all other recent missions. Forty-nine per cent of the attacks in Mission No. 13 were pressed to 250 yards or less, with some attacks closing to 10 and 20 yards, and others diving through the formation, distances and percentages are shown in Table No. 6.

TABLE NO. 6 - DISTANCES TO WHICH ATTACKS WERE PRESSED

| DISTANCE (YARDS) | ENCOUNTERS | PERCENTAGE |
|---|---|---|
| 1000 and Over | 7 | 6 |
| 800 to 1000 | 17 | 14 |
| 500 to 800 | 27 | 23 |
| 250 to 500 | 20 | 17 |
| 10 to 250 | 49 | 40 |
| Total | 120 | 100 Per Cent |

F. BREAKAWAYS:

1. As has been the case in all missions to date, the majority of the closely pressed attacks broke into dives or split S'S. Rolls and banks were used often on the attacks which broke at 800 to 1000 yards. The dive was seen more often then any other breakaway maneuver.

G. COORDINATED ATTACKS:

1. Twelve of the 102 attacks were coordinated. Usually the attacks were coordinated by 2 planes either in trail or entering from different direction, but one attack was reported of 7 Tojos entering in trail from 11 and 10 o'clock. The first 4 attacked at 11 o'clock high; the other 3 attempted to follow from the same direction, but drifted back to 10 o'clock. The 4 from 11 opened fire at 750 yards and the 3 from 10 began firing at 1000 yards; all 7 closed to about 200 yards and broke away in fast vertical dives. Our aircraft opened fire on all planes at 1000 yards but no damage was done on either side.

2. In a typical 2-plane attack, 2 Tonys entered in trail at 12 o'clock high. The first fighter opened fire at about 800 yards.





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closed to 400, and broke in a dive. The second Tony held fire to 400 yards, pressed the attack to 100, at which point fire from the upper forward turret knocked pieces off the fighter and caused it to burst into flames. The Tony apparently intended to zoom from its dive and go over the B-29, but after being hit, appeared to dive directly at the B-29, missing the wing by only a few feet as it passed underneath. The fighter by this time was in flames from nose to tail, and was completely out of control.

3. Some of the coordinated attacks employed phosphorous bombs. In a typical attack of this kind, a Tony came in from 1 o'clock high, dropped 2 small bombs from 150 yards above and 400 yards out, after which he pulled up and to his left. The bombs exploded just off the B-29's wing tips. Almost immediately another Tony followed from 1 o'clock high, firing steadily from 800 to 400 yards. The number 3 engine was hit and the prop had to be feathered. Fighters immediately concentrated on the cripple until another B-29 dropped back to lend its assistance.

H. AERIAL BOMBING ATTACKS:

1. Ten of the 14 aerial bombing attacks were single-plane attacks, and 4 were coordinated. All of the latter were 2-plane attacks, and in 2 instances both fighters dropped bombs while in the other 2 only 1 of the enemy planes employed bombs. Both dive bombing tactics and release while in level flight were employed. All bombs used were of the phosphorous type. Although many near misses were reported, no damage was effected by the bombing. One B-29 flew through a steamer of white smoke without damage. A tendency was noted for the bomb to explode soon after release from the fighter indicating that the time fuse setting may have been changed in some instances. Bombs often were dropped in Pairs. The familiar tactics of distracting attention from bombing attacks by means of aerobatics was reported. One extremely large phosphorous burst was noted at 15,000 feet, described as 10 times the size of an A/A burst, and much larger than the ordinary bomb burst. The crew believed that release was not made from an enemy plane. For direction of approach of aerial bombing encounters, see Table No. 4.

I. AERIAL ROCKET ATTACK:

1. Only one rocket attack occurred during the Mission No. 13. Two Zekes approached simultaneously at 5 and 7 o'clock low. The Zeke at 7 opened fire with machine guns at 1000 yards, and the Zeke at 5 o'clock at 1000 yards released what appeared to be a rocket. The B-29 opened fire at 800 yards and both fighters immediately broke away in dives. It is believed that the rocket came from under the Zeke's wing as both wings appeared to have "humps" under them.

2. Additional details on this attack are being collected and further data, if significant, will be the subject of a special intelligence report.

J. NEW AIRCRAFT:

1. What may be a new J P twin-engine fighter was sighted by crews of the 468th Group. The plane was somewhat similar to Nick but the nose was bulbous somewhat like that of the Beaufighter, and the engines seemed to sit well forward on the wing.

2. Additional details on this possible new fighter are being collected and further data, if significant, will be the subject of a special intelligence report.





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closed to 400, and broke in a dive. The second Tony held fire to 400 yards, pressed the attack to 100, at which point fire from the upper forward turret knocked pieces off the fighter and caused it to burst into flames. The Tony apparently intended to zoom from its dive and go over the B-29, but after being hit, appeared to dive directly at the B-29, missing the wing by only a few feet as it passed underneath. The fighter by this time was in flames from nose to tail, and was completely out of control.

3. Some of the coordinated attacks employed phosphorous bombs. In a typical attack of this kind, a Tony came in from 1 o'clock high, dropped 2 small bombs from 150 yards above and 400 yards out, after which he pulled up and to his left. The bombs exploded just off the B-29's wing tips. Almost immediately another Tony followed from 1 o'clock high, firing steadily from 800 to 400 yards. The number 3 engine was hit and the prop had to be feathered. Fighters immediately concentrated on the cripple until another B-29 dropped back to lend its assistance.

H. AERIAL BOMBING ATTACKS:

1. Ten of the 14 aerial bombing attacks were single-plane attacks, and 4 were coordinated. All of the latter were 2-plane attacks, and in 2 instances both fighters dropped bombs while in the other 2 only 1 of the enemy planes employed bombs. Both dive bombing tactics and release while in level flight were employed. All bombs used were of the phosphorous type. Although many near misses were reported, no damage was effected by the bombing. One B-29 flew through a steamer of white smoke without damage. A tendency was noted for the bomb to explode soon after release from the fighter indicating that the time fuse setting may have been changed in some instances. Bombs often were dropped in Pairs. The familiar tactics of distracting attention from bombing attacks by means of aerobatics was reported. One extremely large phosphorous burst was noted at 15,000 feet, described as 10 times the size of an A/A burst, and much larger than the ordinary bomb burst. The crew believed that release was not made from an enemy plane. For direction of approach of aerial bombing encounters, see Table No. 4.

I. AERIAL ROCKET ATTACK:

1. Only one rocket attack occurred during the Mission No. 13. Two Zekes approached simultaneously at 5 and 7 o'clock low. The Zeke at 7 opened fire with machine guns at 1000 yards, and the Zeke at 5 o'clock at 1000 yards released what appeared to be a rocket. The B-29 opened fire at 800 yards and both fighters immediately broke away in dives. It is believed that the rocket came from under the Zeke's wing as both wings appeared to have "humps" under them.

2. Additional details on this attack are being collected and further data, if significant, will be the subject of a special intelligence report.

J. NEW AIRCRAFT:

1. What may be a new J P twin-engine fighter was sighted by crews of the 468th Group. The plane was somewhat similar to Nick but the nose was bulbous somewhat like that of the Beaufighter, and the engines seemed to sit well forward on the wing.

2. Additional details on this possible new fighter are being collected and further data, if significant, will be the subject of a special intelligence report.





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K. NEW TACTICS:

1. Several crews reported a spiralling or corkscrew turn used by enemy fighters as they approached our aircraft. This was a deceptive manuever and make tracking by our gunners extremely difficult.

2. Many cases of aerobatics were recorded.

L. EVASIVE ACTION:

1. The leader of one formation nosed up slightly to bare the belly guns, and this seemed to be a determent against closely pressed attacks from the frontal quarter level or slightly low.

2. No other evasive measures were taken.

M. SUMMARY:

1. Air opposition rated as moderate.

2. Bulk of attacks in primary target area and Saishu Island area on route from target.

3. Twelve B-29's damaged, one destroyed, as a result of enemy air action. Our preliminary claims: 7-5-10.

4. Ninety-two and a half per cent of the attacks after "bombs away".

5. High plane in large formations attacked slightly more often than other plane. Same is true of number 4 plane in 4-plane formations.

6. Majority of attacks from the frontal quarter; 40 per cent of all attacks high, 40 per cent low.

7. Enemy opened fire in 68 per cent of the encounters, and B-29's in 92 per cent. Much of the firing on both sides done at long ranges.

8. Enemy attacks aggressive; 49 per cent pressed to 250 yards or less.

9. Twelve coordinated attacks, 14 aerial bombing attacks, and 1 rocket attack reported. All bombs of the phosphorous type.

10. Possible new twin-engine fighter reported.

11. Little evasive action by B-29's.

N. ENEMY AIRCRAFT MARKINGS:

| AIRCRAFT | COLOR | MARKINGS |
|---|---|---|
| Tojo | Dapple | White stripes on tail. |
| Tojo | Black | 2 red stripes on upper surface left wing. |
| Tojo | Slate | |
| Tojo | Black | Red dot circled in blue |
| Tojo | Black | |
| Tojo | OD | Red discs on wings and fuselage. |
| Tojo | Silver | Red jap insignia. |



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| AIRCRAFT | COLOR | MARKINGS |
|---|---|---|
| Tojo | | Yellow wing tips. |
| Tojo | | Striped. |
| Tojo | | Silver and red ball on wings and fuselage. |
| Tojo | OD | |
| Tony | | Red and yellow stripes on wings |
| Tony | Silver | |
| Tony | Silver | |
| Tony | Dark OD | Red discs on wings |
| Tony | Dark OD | Red balls on wings |
| Tony | Dark Green | Red discs on wings. White band on fuselage. |
| Zeke | Slate | |
| Zeke | Gray | |
| Zeke | Black & Silver | Black wings, silver belly. |
| Zeke | | Orange stripes on fuselage. |
| Zeke | | Orange stripes on fuselage. |
| Zeke | Silver | Red spinner. |
| Oscar | Camouflaged | |
| Oscar | OD | |
| Oscar | | White stripes on fuselage near tail. |
| Nick | Black | |
| Nick | OD | |
| New T/E | Black | Red stripes behind canopy. |

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Distribution:
Originator:
Action: None
Information: CS; DC/S, Opr. (5 cys), A-2 (10 cys), A-3 (OC&R) (5 cys)



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HEADQUARTERS, TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

SECRET
By authority of -
C.G., Twentieth Air Force
10 Nov 44 JD
(Date) (Initials)

EXTRACT OF TELETYPE CONFERENCE BETWEEN
WASHINGTON AND HONOLULU

Washington Parties — Honolulu Parties

Lt. Col. Hewitt — Col. Ankenbrandt

Telecon Message No. 10-G

SUBJECT: Special Report on Primary Targets Nos. 1176, 1177, and 1219.

H: (From Harmon to Norstad)

Quoted herewith is Telecon Message 09-G from BomCom XXI:

"Special report on Primary Targets Nos. 1176, 1177, and 1219. Following information gained on subject targets from photos of our first Mission:

1. Target 1176 - Alumina plant was well covered with a 24" camera. This target was verified as the Alumina plant. According to Objective Folder No. 90.18 it is the largest Alumina plant in Japan. Photograph numbers covering this target are 4K2-3; 1, 2, and 3. It is also covered by tri-metrogen and the 40" camera. Location as shown in Objective Folder 90.18 and AAF Target Chart 90.18-1176 is verified. A special interpretation report is being prepared on this Target.

2. Target 1177 was covered by the 6" camera only. Photographs are not suited for interpretation but plant and location are as shown in the Objective Folder 90.18. Photograph number covering the Target is 4K2 1 V: 19.

3. Target Number 1219 was covered by 24" camera. This is an aircraft propeller company. It is one of the most important companies in Japan. Photographs covering this Target are 4K2-417 and 418. Plant has undergone expansion practically doubling its size. A special report on this plant is being prepared."

DISTRIBUTION:

ACTION: DC/S Op (3 copies)

INFORMATION: C3; A-2 (10 copies); A-3 OCAR (5 copies); A-5 Plans (1 copy)

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prominent radar responses that will help setting the plane on the blind bombing run. Anybody, even slightly aquainted with Japanese climatology, will readily realize that there are several months during the year when radar missions will have to be run in addition to visual ones, because the opportunities for visual missions are far below the operational capabilities of the Field Commands. On the return from long range missions, it is essential that the aircraft will find its base. The bases, as you know, are specks in a vast ocean with no alternates available. Even with radio-aids to navigation, weather plays an important role because of the special problems offered by atmospheric and precipitation static, which at times blocks the radio reception facilities. Because of its size and speed the B-29 is an airplane critically affected by these static electric conditions. Whenever the radio-aids fail, good wind forecasts are the mainstay of the navigator under instrument flying conditions. The navigation problem in poor weather conditions will influence long-range fighter airplanes even more than the bombers, which, afterall, have navigators and all kinds of radio-navigation equipment. It can be foreseen that for long range fighters weather will be absolutely a matter of life and death. Small islands are the bases to which they will have to return and marginal gas reserves will make good forecasting imperative. Base weather conditions at the present B-29 bases in POA are only rarely below the necessary minima for take-offs or landings and then only for brief periods of time in intense shower. For the fighters, which will be based much closer to the bad weather belt, great difficulties can be foreseen regarding take-off and landing conditions.

Other special weather problems connected with VLR operations are icing and turbulence. How important an element icing will be during operations in the dense, high reaching cloud masses of the summer monsoon remains to be seen. In operations of VLR a/c in CBI last year, occasional trouble was encountered. Turbulence, while perhaps not as important as the previously mentioned weather factors also plays a role. In one case on record, turbulence has caused the bombs of a B-29 to break lose from their shackles and fall through the closed bomb-bay door and of course, not on the target. That may be a singular instance, but the more subtle effects of turbulence cannot be neglected. One is gasoline consumption. Present records indicate that high turbulence will lead to greater gas consumption. Another factor is crew fatigue. Long range missions of perhaps 15 hours of flight are fatiguing in themselves. Add to this the nervous strain of combat, then severe turbulence is an unwelcome additional factor of fatigue.

A final point is that base weather conditions on days when no combat missions are flown, have an influence on VLR operations. Hurricanes or tornadoes that strike the bases can create more havoc than enemy action. Such special events have to be foreseen. Evacuation schemes based on good forecasting have to be planned for. Base weather conditions also have an important bearing on maintenance work. Present facilities require repair and maintenance work in the open. Excessive heat, as has been encountered in the pre-summer monsoon season in India, will permit no day-time maintenance work. Hence aircraft that are non-operational will remain longer in that condition when such weather prevails. Frequent,



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excessive rainfall as in normal during certain parts of the year on the bases in the Marianas also has an adverse influence on maintenance work. Even here good forecasting, although it can not change conditions, can contribute to mitigate the effects by permitting certain adjustments in work planning.

HELMUT B. LANGSDORF
Operations Analyst
Twentieth Air Force

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7 April 1945

Weather and Very Long Range Air Operations

Since no specific topics were assigned to me for discussion before this meeting, I thought it might perhaps be profitable to present some of the weather factors influencing VLR air operations. This presentation is less concerned with the strictly synoptic forecast problems rather than the operational problems involving weather. I shall try to point out some of the things where, by accurate forecasting the meteorologist can help to contribute to the success of operations.

The purpose of the VLR air force is to lay bombs on strategic enemy targets. This purpose is accomplished by VLR bombardment aircraft, at present essentially B-29s. Incidental to the protection of these bombers from enemy opposition will be VLR fighter operations. Both, VLR bomber and fighter operations against Japan from the bases presently occupied by our forces are at the limit of their respective range, that in the case of the bombers is compatible with a reasonable bombload. Present operations are high level and low level precision bombing of strategic pin-point targets and attacks on large industrial and urban areas which are important to the enemy's war potential. For all these purposes the target weather forecast is a most important planning element. This forecast is essentially a forecast of cloudiness at various levels for a small area for a specified short period of time, the target time, rarely exceeding one or two hours, 24 or more hours in advance. In a good many cases, command decisions are based on this particular phase of the overall operational weather forecast. Most desirable for nearly all purposes of strategic bombing are visual conditions. Generally, only cloud conditions of 3/10 or less total cloudiness below bombing altitude are unqualifiedly good for visual precision bombing. But not only the cloud amounts are of importance but also their heights because, if the tactical situation permits, an elevation can be sought at which cloudiness below is at a minimum. In order to let the strategic VLR air force accomplish its mission efficiently and expeditiously it is not only most desirable that forecasts calling for little or no cloudiness at the targets are correct, so that a task force that is sent out to exploit such weather conditions will find them verified, but it is equally important that all such situations are properly forecast. If on the basis of a forecast for considerable target cloudiness no mission is scheduled and it turns out that cloudiness would have been favorable for one, a valuable opportunity is missed and has to be made up for later, which means that the war is actually prolonged by such a failure.

The success of VLR aircraft to do accurate bombing from high altitudes is quite remarkable. On clear days, units of the Twentieth Air Force have been able to deposit from high altitudes 60 percent of their bomb loads within 1000 feet of the aiming point. Targets attacked under such conditions have been effectively crippled, or even completely

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OFFICE OF THE COMMANDING GENERAL
WASHINGTON 25, D. C.

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CG, 20th Air Force
4 Jan 45 I.I.
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EXTRACT TELETYPE CONFERENCE BETWEEN WASHINGTON AND HONOLULU (GUAM)

| WASHINGTON PARTIES | HONOLULU PARTIES |
|---|---|
| Lt. Col. Hewitt | Col. Ankenbrandt |

Telecon Message No. G-3-10

SUBJECT: Japanese Fighter Tactics - Mission No. 22

(To: COMGENBOMCOM 21 Info: DEPCOMAF 20 From: COMGENAF 20)

Following is a detailed description of enemy fighter opposition encountered on Mission No. 22.

I. JAPANESE FIGHTER TACTICS - MISSION NO. 22
TARGET: Omura, Japan
TIME: Day Mission DATE: 19 December 1944

1. GENERAL

A. Enemy opposition was weak to moderate considering the comparatively small force of B-29's employed. Of the 36 B-29's airborne to Targets, 21 were intercepted by an enemy force estimated at 22 Tojos, 9 Tonys, 3 Zeke 32's, 50 Oscars, 3 Nicks, 4 Zekes, 1 Val, 2 unidentified Single Engine Fighters, and 3 unidentified enemy aircraft. Ninety three individual encounters developed from 53 single and 13 coordinated attacks. The latter attacks, employing 29 enemy aircraft, were responsible for 40 encounters, 43 percent of the total. No B-29's were reported destroyed or damaged due to enemy air action. Preliminary claims against enemy aircraft were 5 destroyed, 4 probably destroyed and 12 damaged.

B. There were no encounters reported enroute to Target areas.

C. Sixty-three encounters occurred in the Omura Target area, all of which were after Bombs Away. Action continued throughout a period of 31 minutes, from 0130Z to 0201 Z, and at altitudes from 18000 to 23,000 feet. Thirteen encounters were reported in the Shanghai Target area, 9 of which were before Bombs Away, 1 during Bombs Away, and 3 after Bombs Away. The attacks occurred between 0353Z and 0426Z, at altitudes from 20,000 to 25,000 feet. The remaining encounters, 17, occurred principally in the areas north, south and west of Nanking. These interceptions were made against B-29's returning from the Omura and Shanghai Targets, and were spread over a period of 1 hour and fifty minutes from 0515Z to 0705Z at altitudes from 14,000 to 17,000 feet.

D. Details of encounters, including total individual encounters by each type enemy aircraft follows:



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TABLE NO. 1 - DETAILS OF ENCOUNTERS

| LOCATION | NO. OF ENCOUNTERS | TYPE OF E/A | TIME | ALTITUDE |
|---|---|---|---|---|
| Primary Target (Omura) | 63 | 34 by Tojo<br>6 by Zeke 32<br>6 by Val<br>5 by Tony<br>4 by Oscar<br>3 by Zeke<br>2 by Nick<br>2 by S/E<br>1 by unidentified enemy aircraft | 0130Z to 0201Z | 18,000 to 23,000 |
| Secondary Target (Shanghai) | 13 | 3 by Oscar<br>2 by Tojo<br>2 by Tony<br>2 by Nick<br>1 by Zeke<br>3 by unidentified enemy aircraft | 0353Z to 0426Z | 20,000 to 21,000 |
| 35 miles S of Nanking | 2 | 2 by Tony | 0515Z | 16,000 |
| 40 miles S of Nanking | 1 | 1 by Zeke | 0520Z | 17,000 |
| 32 degrees 30'N-<br>118 degrees 19'E | 1 | 1 by Tony | 0535 | 15,000 |
| 32 degrees 20'N-<br>118 degrees 00'E | 1 | 1 by Tojo | 0537Z | 14,000 |
| 32 degrees 30'N-<br>118 degrees 45'E | 2 | 2 by Tony | 0537Z | 15,000 |
| 32 degrees 20'N-<br>118 degrees 00'E | 1 | 1 by Tojo | 0540Z | 14,000 |
| 32 degrees 25'N-<br>118 degrees 25'E | 1 | 1 by Tony | 0542Z | 14,600 |
| 32 degrees 30'N-<br>118 degrees 45'E | 1 | 1 by Tony | 0600Z | 15,000 |
| Location Unreported | 5 | 5 by Tojo | 0658Z to 0705Z | 14,000 |
| 31 degrees 55'N-<br>112 degrees 50'E | 2 | 2 by Tojo | 0725Z | 14,000 |

2. DIRECTION AND LEVEL OF APPROACH

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A. Encounters originating from the Right Quarter were in the Majority, 41 percent, for the second time since B-29's have been meeting major air opposition. The first occasion was on Mission No. 18 when encounters from the Right Quarter were 52 percent of total encounters. Of the remainder on Mission No. 22, 22 percent came from the Rear Quarter, 18 percent from the Left Quarter, and 19 percent came from the Frontal Quarter. It is interesting to note that the Frontal Quarter which, except for Mission No. 18, has been consistently high in percentages over other quarters since Mission No. 7 dropped into third place on Mission No. 22. It is a decided change but does not necessarily denote a definite change in tactics inasmuch as 3 of the 53 13 coordinated attacks were largely responsible for the shift, accounting for 20 individual attacks (21 1/2 percent of the total encounters) from the 3 o'clock position.

B. As to level of approach, another interesting change was noted in the predominance of low attacks - 53 percent. High approaches were 39 percent, and level approaches were 8 percent. The coordinated attacks mentioned in the preceding paragraph were largely responsible for this change, too, as the level of approach for all 20 attacks was low.

C. A summary of direction and levels of approach for all encounters is shown in Tables No. 2 and No. 3

TABLE NO. 2 - DIRECTION AND LEVEL OF APPROACH

| Direction of Encounter | Front | | | Right Side | | | Rear | | | Left Side | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| High | 4 | 4 | 2 | 6 | 2 | 1 | 4 | 0 | 4 | 1 | 0 | 8 | 36 (39 PC) |
| Level | 0 | 2 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 8 (8 PC) |
| Low | 3 | 0 | 1 | 3 | 21 | 5 | 4 | 2 | 3 | 3 | 3 | 0 | 49 (53 PC) |
| TOTAL | 7 | 6 | 5 | 9 | 23 | 6 | 11 | 2 | 7 | 4 | 5 | 8 | |
| | 18 | (19 PC) | | 38 (41 PC) | | | 20 (22 PC) | | | 17 (18 PC) | | | 93 (100 PC) |

TABLE NO. 3 - LEVEL OF APPROACH

| Level of Approach | Front | Right Side | Rear | Left Side |
|---|---|---|---|---|
| High | 10 (55 PC) | 9 (24 PC) | 8 (40 PC) | 9 (53 PC) |
| Level | 3 (17 PC) | 0 | 3 (15 PC) | 17 (12 PC) |
| Low | 5 (28 PC) | 29 (76 PC) | 9 (45 PC) | 6 (35 PC) |
| TOTAL | 18 (100 PC) | 38 (100 PC) | 20 (100 PC) | 17 (100 PC) |

3. EXCHANGE OF FIRE

A. Japanese pilots opened fire in 60 of the 93 encounters (64 percent) and in 38 of the 60 at ranges under 1000 yards (63 percent). B-29's opened fire in 88 of the 93 encounters (95 percent). A higher percentage of fire than on any recent mission. It may be noted regardless of the high percentage of B-29 fire, the enemy percentages for fire were about normal in comparison with recent missions. A contributing factor may have been the tendency of B-29's on this mission to open fire at shorter ranges than usual. An examination of Table No. 4 indicates that B-29 fire at ranges of 1000 yards and over was only 30 percent, compared to Missions No. 21 (34 percent) No. 19 (59 percent) and No. 18 (42 percent). The percentage of B-29 fire in the 500 to 799 yard bracked (34 percent) was higher than on Missions No. 21, 19 and 18. Table No. 4 shows comparative percentages at various ranges.



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TABLE NO. 4 - DISTANCES OPENED FIRE

| | ENEMY FIRE | | B-29 FIRE | |
|---|---|---|---|---|
| Distance (Yards) | No. of attacks | Percent | No. of attacks | Percent |
| 0 to 499 | 4 | 7 | 10 | 11 |
| 500 to 799 | 8 | 13 | 30 | 34 |
| 800 to 999 | 26 | 43 | 22 | 25 |
| 1000 & Over | 22 | 37 | 26 | 30 |
| TOTAL | 60 | 100 | 88 | 100 |

4. AGGRESSIVENESS OF ENEMY ATTACKS AND PILOT ABILITY

A. Japanese pilots exhibited a curious lack of aggressiveness on Mission No. 23 in comparison to previous missions, with only 17 of the 93 encounters (18 percent) pressed to distances under 250 yards. This compares to Missions No. 21 (45 percent), No. 19 (52 percent), No. 18 (53 percent), No. 17 (38 percent) and No. 16 (53 percent). Only one instance was reported of an enemy pilot flying through a formation. As to pilot ability, the reluctance on the part of the Japanese pilots to press their attacks closely, combined with the fact that no B-29's were reported damaged due to enemy air action, may be taken as an indication that the enemy pilots were not up to their usual standards for Omura.

B. Distances to which enemy attacks were pressed are shown in Table No. 5.

TABLE NO. 5 - DISTANCES TO WHICH ATTACKS WERE PRESSED

| Distance (Yards) | No. of encounters | Percent |
|---|---|---|
| 1000 & Over | 10 | 11 |
| 800 to 999 | 10 | 11 |
| 500 to 799 | 34 | 36 |
| 250 to 499 | 22 | 24 |
| 0 to 249 | 17 | 18 |
| TOTAL | 93 | 100 |

5. AERIAL BOMBS

A. Aerial bombs, principally of the phosphorous type, were reported employed in 10 encounters (11 percent of total encounters) but caused no damage to any B-29. No new or unusual tactics were reported although aerial bombing attacks were encountered in all areas where B-29's met air opposition.

B. An interesting coordinated attack in which aerial bombs were used was reported by a 3 plane formation of B-29's flying over Shanghai at 20,000 feet, with the sun at 6 o'clock. Three Oscars were sighted at 2000 yards approaching in line astern from 12 o'clock high. The lead B-29 opened fire at 1200 yards. The Oscars returned the fire at 1000 yards and kept coming in. Each Oscar, as he cleared the top of the formation by about 100 feet, dropped a phosphorous bomb, then staying on course, headed directly into the sun. No B-29's were reported damaged nor were any claims made against the Oscars.

C. One B-29 reported an attack with phosphorous type bombs in which 2 bombs exploded about 400 feet above a formation, with streamers spreading out to cover the B-29's. The crew of the airplane reporting the attack stated that its left wing was hit by the streamers but the embers slid off inflicting no damage.



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| | ENEMY FIRE | | B-29 FIRE | |
|---|---|---|---|---|
| Distance (Yards) | No. of attacks | Percent | No. of attacks | Percent |
| 0 to 499 | 4 | 7 | 10 | 11 |
| 500 to 799 | 8 | 13 | 30 | 34 |
| 800 to 999 | 26 | 43 | 22 | 25 |
| 1000 & Over | 22 | 37 | 26 | 30 |
| TOTAL | 60 | 100 | 88 | 100 |

4. AGGRESSIVENESS OF ENEMY ATTACKS AND PILOT ABILITY

A. Japanese pilots exhibited a curious lack of aggressiveness on Mission No. 22 in comparison to previous missions, with only 17 of the 93 encounters (18 percent) pressed to distances under 250 yards. This compares to Missions No. 21 (45 percent), No. 19 (52 percent), No. 18 (53 percent), No. 17 (38 percent) and No. 16 (53 percent). Only one instance was reported of an enemy pilot flying through a formation. As to pilot ability, the reluctance on the part of the Japanese pilots to press their attacks closely, combined with the fact that no B-29's were reported damaged due to enemy air action, may be taken as an indication that the enemy pilots were not up to their usual standards for Omura.

B. Distances to which enemy attacks were pressed are shown in Table No. 5.

TABLE NO. 5 - DISTANCES TO WHICH ATTACKS WERE PRESSED

| Distance (Yards) | No. of encounters | Percent |
|---|---|---|
| 1000 & Over | 10 | 11 |
| 800 to 999 | 10 | 11 |
| 500 to 799 | 34 | 36 |
| 250 to 499 | 22 | 24 |
| 0 to 249 | 17 | 18 |
| TOTAL | 93 | 100 |

5. AERIAL BOMBS

A. Aerial bombs, principally of the phosphorous type, were reported employed in 10 encounters (11 percent of total encounters) but caused no damage to any B-29. No new or unusual tactics were reported although aerial bombing attacks were encountered in all areas where B-29's met air opposition.

B. An interesting coordinated attack in which aerial bombs were used was reported by a 3 plane formation of B-29's flying over Shanghai at 20,000 feet, with the sun at 6 o'clock. Three Oscars were sighted at 2000 yards approaching in line astern from 12 o'clock high. The lead B-29 opened fire at 1200 yards. The Oscars returned the fire at 1000 yards and kept coming in. Each Oscar, as he cleared the top of the formation by about 100 feet, dropped a phosphorous bomb, then staying on course, headed directly into the sun. No B-29's were reported damaged nor were any claims made against the Oscars.

C. One B-29 reported an attack with phosphorous type bombs in which 2 bombs exploded about 400 feet above a formation, with streamers spreading out to cover the B-29's. The crew of the airplane reporting the attack stated that its left wing was hit by the streamers but the embers slid off inflicting no damage.



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D. An "Incendiary Cluster Bomb" was dropped by an unidentified enemy aircraft about 1000 yards in front and 200 feet above a formation. The bomb exploded, scattering what was described as 6 inch squares of flat metal over a 200 foot area. The attack was made on a formation of 3 B-29's about 35 miles south of Nanking, as they were returning from Shanghai, the Secondary Target, at 16,000 feet.

6. ROCKETS No rockets attacks were reported.

7. COORDINATED ATTACKS

A. Thirteen coordinated attacks, employing 29 enemy aircraft were reported. They accounted for 40 individual encounters, 43 percent of the total. The majority of attacks were executed by teams of 2 enemy aircraft, but several were also reported in which 3 and 4 were employed. In one attack, in which 4 enemy aircraft came in from 10 o'clock high out of the sun, it was thought that two additional enemy planes were used as decoys. These two stayed out of range at 7 and 8 o'clock while the others pressed their attack.

B. Five of the 13 coordinated attacks were executed with low approaches which is somewhat out of the ordinary for this type attack. Two typical examples follow:

(1) The B-29 was the leader of "D" Flight, flying in a spread out 10 plane formation on its return flight from the target area, at 15,000 feet. Two Tonys were sighted at 2000 yards, low; one coming in from 11 o'clock just a few seconds ahead of the other. Each Tony in his pursuit curved opened fire at 1000 yards, closed to 500 yards, then broke away under the formation. The B-29 opened fire at 800 yards and claimed damage on the 2 -5'clock. It appeared like a well timed attack with the Tony at 11 o'clock and the other from 1 o'clock. It appeared like a timed attack with the Tony at 11 o'clock just a few seconds ahead of the other. Each Tony in his pursuit curved opened fire at 1000 yards, closed to 500 yards then broke away under the formation. The B-29 opened fire at 800 yards and claimed damage on the 51 o'clock Tony. The other was hot hit. No damage was reported to the B-29.

(2) Four Tojos executed approximately 15 attacks in a chow line maneuver, but with a slight variation - a low approach instead of the usual high. The attacks were directed principally against a B-29 flying in No. 3 position of a 3 plane formation. Each Tojo made 3 to 4 individual passes in such rapid succession that it was impossible to keep an accurate count and the total of 15 attacks was an estimate. Approaches were from 3 o'clock low, and the first enemy aircraft was sighted at 1200 yards. -153 after each Tony banked in to attack the enemy pilot opened fire at 900 yards, continued on to 400 yards, and claimed 1 destroyed and 1 probably destroyed. No damage was reported to the B-29. Note: On Mission No. 18 (Bangkok) a single Tojo attacked the low B-29 in a 12 plane formation, using a familiar method of approach. Refer to Section 8, Paragraph B of Enemy Tactics Report, Mission No. 18.

8. COLLISIONS OR RAMMINGS None; nor were any attempts reported.

9. BREAKAWAYS: Dives, as usual, predominated to a marked degree, with some preceded by fast half-rolls. A number of peel-offs were reported. Some instances were reported in which enemy aircraft climbed into the sun after completing their attacks.

10. EVASIVE ACTION: One group reported their wing airplanes uncovered guns to meet attacks by changing from high to low position when necessary. Others reported that their pilots occasionally nosed their airplanes down in short dives or increased the indicated air speed.

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D. Japanese pilots fired in 64 percent of the encounters and B-29's in 95 percent. B-29's showed tendency to fire at closer ranges than usual.

E. Enemy pilots were not aggressive. Breadaways were at much greater distances than usual. Enemy attacks as a whole did not appear to be up to their usual standards for Omura.

F. Aerial bombs were employed in 10 of the 93 encounters and were mostly of the phosphorous type.

G. Thirteen coordinated attacks accounted for 40 individual encounters, 43 percent of the total, many executed with low approaches.

H. No reports of attempts to ram. No rocket attacks.

I. Dive was the most common breakaway maneuver.

14. ENEMY AIRCRAFT MARKINGS

| COLOR | ENEMY AIRCRAFT | WING AND FUSELAGE MARKING | TAIL MARKING |
|---|---|---|---|
| Silver | Oscar | No markings observed | |
| Silver | Tony | No markings observed | |
| Silver | Tojo | Red roundels | |
| Silver | Zeke | Red roundels | |
| Black | Zeke | Red roundels | |
| Black | Tojos | No markings observed | |
| Black | Val | No markings observed | |
| Black | Tonys | Stripe around fuselage | |
| 4 brownish red | S/E | No markings observed | |
| Dull gray | Zeke 32 | Red roundels | |
| Camouflaged | Tony | No markings observed | |
| Camouflaged | | No markings observed | |
| Yellow-Brown | Tojo | | |
| Grey-Green | Tony | Red nose | |
| Olive drab | Tojo | ——————— | 1 six inch white stripe horizontal on vertical stabilizer |

Note: One group reported that most of the enemy aircraft encountered were camouflaged a dark mottled green. No silver enemy aircraft were observed.

DISTRIBUTION ACTION: None
INFORMATION: CS; DC/S Opr; (2 cys); A-3 (13 cys); A-3 OC&R (5 cys); Stat Con (2 cys); Op Anal; (5 file)

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ROBERT M. BARTENSTEIN
2nd Lt., AC
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TWENTIETH AIR FORCE OPERATIONS
1 - 15 APRIL

19 April 1945

I - HIGHLIGHTS

The 21st Bomber Command surpassed its March records during the first half of April, flying at the monthly rate of 11 sorties per U.E. and dispatching an average of 242 A/C (74% of U.E.) on major missions every other day. Total B-29 sorties for the 15 days, including weather strikes, numbered 1739, and tonnage "delivered" to Japan was over 9000 compared to 13,700 tons for the entire month of March. Eight of the 14 major missions, some of which were run simultaneously, were directed against aircraft plants and installations (constituting 47% of the bombing sortie effort), four missions (43% of the effort) were area raids, and two (10% of the effort) hit chemical plants.

The 20th Bomber Command, in preparation for its move, has been inactive during April.

April, furthermore, marked the first fighter-escorted B-29 mission over Japan. On 7 April 90 Mustangs of the 7th Air Force (out of 116 airborne) provided cover for a hundred-odd Superforts in a daytime, medium-altitude attack against the Nakajima Aircraft Engine Plant at Musashino, on the outskirts of Tokyo. With CAVU weather at the target, the heaviest and most aggressive fighter opposition in the past six weeks was encountered; there were 650 individual attacks by enemy aircraft. B-29's claimed 50 Jap fighters destroyed, and P-51's claimed 21. Jap fighters succeeded in downing only one Superfort, the victim of an air-to-air phosphorus bomb; two more were brought down by flak. Three P-51's failed to return to base.

Mustangs (86 out of 125 airborne) escorted another day mission against the same target on 12 April. Air opposition was described as slight, and no B-29's were lost. On the other hand, 18 enemy planes were claimed destroyed, 8 by B-29's and 10 by P-51's.

Outstandingly successful April raids were those against the Mitsubishi Aircraft Plant at Nagoya, which has now been virtually wiped out with 90% of the original roof area destroyed or damaged including all major buildings, against a chemical plant at Koriyama, where 82% of the original roof area was destroyed or damaged, and against the arsenal complex in the northwest section of Tokyo, where photos show 10.7 square miles of new damage. Weather was clear for all three of these raids, and bombing was visual except in the case of that part of the force bombing Tokyo which arrived over the target after smoke from earlier bombs obscured visibility. Two more incendiary raids on 15 April added 9.2 square miles in South Tokyo to the previously observed Tokyo damage, and also damaged 2.9 square miles in Kawasaki. Fifty-three numbered industrial targets in Tokyo, Kawasaki, and Yokohama show damage as a result of the three April incendiary raids. The 21st Bomber Command reports that cumulative visible damage in Tokyo City now covers an area of 32.7 square miles.

The loss rate has risen in April. More B-29's were lost on combat missions (36) in 15 days than during the entire month of March. However, only 20% of March bombing mission sorties were directed against Tokyo, where the enemy appears to have concentrated his best defenses, both air and ground, while 73% of April sorties have so far been dispatched against Tokyo and environs. The loss rate per sortie on April raids against the Tokyo area has been 2.3%, compared to a rate of 1.5% on raids against other targets. Comparative March data was 2.9% against Tokyo and 0.7% against other targets.

APRIL (1-15) EFFORT
(Preliminary)

| Sorties | A/C Bombing | Tons Dropped | AIRCRAFT LOST On Missions | Total | A/C Dropped to 2nd Line | E/A Destroyed |
|---|---|---|---|---|---|---|
| 1739 | 1510 | 9419 | 36 | 40 | 1 | 82 |

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## XI - ACTIVITY AND LOSS RATES

The revision of sortie figures to include weather strike and search missions has produced minor changes in some of the following rates since the last issue of this report.

It is notable that the 21st Bomber Command during April has maintained and in some cases improved on its March performance. The sortie rate per U.E. is higher, and a larger per cent of aircraft succeeded in bombing the primary target, with a significant improvement in the efficiency of daytime missions.

Loss rates increased above the low March level and are again higher than the planned monthly attrition rate.

### TWENTY-FIRST BOMBER COMMAND

**EFFORT**

| | Jan | Feb | Mar | Apr[1] |
|---|---|---|---|---|
| Sorties per U.E. | 5.6 | 5.22/ | 10.22/ | 11.0 |
| (Planning Rate) | (6) | (8) | (9) | (10) |
| Sorties per A/C in Theater | 3.7 | 3.5 | 6.8 | 7.3 |
| Sorties Bombing | 82% | 87% | 93% | 93% |
| Sorties Bombing Prim. Target | 44% | 50% | 84% | 86% |
| Day Sorties Bombing P.T. | 44% | 50% | 57% | 85% |
| Visual Bombing | 39% | 19% | 57% | 3/ |
| Radar Bombing | 5% | 31% | 0 | 3/ |
| Night Sorties Bombing P.T. | - | - | 91% | 86% |
| Sorties Failing to Bomb P.T. due Mechanical Failure | 22% | 13% | 6% | 3/ |
| Av. Bomb Load (Tons) | 2.7 | 2.8 | 5.9 | 5.8 |
| (Planning Rate) | (5) | (5) | (5) | |
| Total Flying Hrs. per U.E. | 90[4]/ | 85[5]/ | 171 | 148 |
| (Planning Rate) | (115) | (115) | (150) | (155) |
| Total Hrs. per A/C in Thea. | 50[4]/ | 57[5]/ | 114 | 98 |
| Combat Hrs. per Sortie | 14.2 | 14.7 | 14.5 | 3/ |
| (Planning Rate) | (15) | (15) | (15) | (14) |

**COST**

| | Jan | Feb | Mar | Apr[1] |
|---|---|---|---|---|
| A/C Lost on Combat Mission per Sortie | 4.6% | 3.0% | 1.2% | 2.0% |
| Total A/C Lost per Sortie | 5.0% | 3.5% | 1.3% | 2.2% |
| Total A/C Lost per U.E. | 28% | 18% | 13% | 25%6/ |
| (Planning Rate) | (16%) | (16%) | (16%) | (16%) |
| Tons Dropped on Targets per A/C lost | 37 | 58 | 392 | 235 |

Notes: U.E. adjusted. Sortie and hour data revised to include weather strike and search missions. Bombing data based on bombing missions only.

1/ April rates based on 1-15 operations, developed to a monthly basis.
2/ Feb: 73rd Wing - 5.0 sorties per U.E.; 313th Wing (504, 505 Gps.) - 4.2
Mar: 73rd Wing - 10.9 sorties per U.E.; 313th Wing - 9.5; 314th Wing -9.6
3/ Not available.
4/ 73rd Wing only.
5/ 73rd and 313th Wings only.
6/ Includes one B-29 dropped to second line.





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## III - MISSION DETAIL

Tactics in the April missions varied considerably. Half of the 14 major missions were by day, half by night. The night attacks were mostly below 10,000 feet, and one of the day attacks was also low level. On the other day missions bombing was mostly from 10,000 to 21,000 feet.

Visual bombing was possible on four of the day missions; on two more bombing was mixed; on the seventh the target was completely obscured and bombing was by radar. Complete undercast was encountered on only two of the seven night raids; however, some radar bombing was also necessary on the other five night raids because of smoke, haze, and scattered clouds.

| DATE (Apr) | PRIMARY TARGET | SORTIES (B-29) | A/C BOMBING PRIMARY (Alt) 1/ | A/C BOMBING OTHER | TONS DROPPED PRIMARY (Type) | TONS DROPPED TOTAL | A/C LOST (B-29) | DAMAGE |
|---|---|---|---|---|---|---|---|---|
| 2 (Night) | Nakajima Musashino A/C Eng. Pl., Tokyo | 127 | 112 (Low) | 0 | 1008 (GP) | 1008 | 6 | No new dam. visible |
| 4 (Night) | Shizuoka A/C Pl., Honshu | 49 | 48 (Low) | 0 | 240 (GP) | 240 | 0 | No information |
| 4 (Night) | Nakajima A/C Pl., Kumagai, Honshu | 78 | 42 (Low) | 20 | 275 (GP) | 403 | 0 | 10% orig roof area |
| 4 (Night) | Tachikawa A/C Pl., Honshu | 113 | 50 (Low) | 48 | 515 (GP) | 917 | 1 | 10% orig roof area |
| 7 (Day) | Nakajima Musashino A/C Eng. Pl, Tokyo | 111 | 104 (Med) | 1 | 520 (GP) | 523 | 3 | 40 hits among main bldgs. |
| 7 (Day) | Mitsubishi A/C Pl, Nagoya | 194 | 158 (Med-Hi) | 23 | 671 (GP) | 769 | 4 | 90% orig roof area, incl. all main bldgs. |
| 8 (Day) | Kagoshima City Area & Kanoya East A/F, Kyushu (2 missions) | 54 | 48 (Med-Hi) | 0 | 194 (GP) | 194 | 1 | Kagoshima - 1,260,000 sq. feet |
| 12 (Day) | Nakajima Musashino A/C Eng Pl, Tokyo | 114 | 96 (Med-Hi) | 12 | 492 (GP) | 557 | 0 | Slight new dam. total to date 22.2 sq. mi. |
| 12 (Day) | Hodogaya Chem Ind, Moriyama, Honshu | 82 | 63 (Med) | 12 | 259 (GP) | 308 | 0 | 61% orig roof area |
| 12 (Day) | Moriyama Chem Ind Moriyama, Honshu | 8 | 74 (Low) | 3 | 379 (GP) | 186 | 2 | 82% orig roof area |
| 13 Night | Tokyo Arsenal Complex, NW section | 348 | 328 (Low to Hi) | 4 | 2088 (Incen.) | 2115 | 7 | 10.7 sq. mi. new dam. |
| 15 (Night) | Kawasaki Urban Area, Honshu | 219 | 204 (Low) | 1 | 1146 (Incen.) | 1154 | 11 | 2.9 sq. mi. |
| 15 (Night) | Tokyo Urban Area | 120 | 109 (Low) | 0 | 769 (Incen.) | 769 | 0 | Cum. visible dam to date: 92.7 sq. mi. |
| TOTAL | 14 Missions | 1694 2/ | 1341 | 124 | 8353 | 9143 | 35 | |
| | Weather Strikes | 45 | 3/ | 3/ | 3/ | 3/ | 1 | |
| | Special Operations | 50 | 45 | 0 | 276 | 276 | 0 | |
| GRAND TOTAL | | 1789 | 1436 | 124 | 8629 | 9419 | 36 | |

Note: The above data are taken from preliminary cabled reports and are subject to revision.

1/ Altitude definitions for the purposes of this report are:
Below 10,000 - Low
10,000 - 15,000 - Medium
15,000 - 21,000 - Medium-High
21,000 - 27,000 - High
Above 27,000 - Very High

2/ Includes 10 A/C not carrying bombs

3/ Complete data not available

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19 April 1945



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NO. 9 (PROVISIONAL)

Manchuria

9930

TARGET: Showa Iron and Steel Works, Anshan, Manchuria, (41° 08' N - 122° 58' E).

GENERAL STATEMENT:

x 20 AF air force

This report relates to damage resulting from a daylight attack by 83 aircraft of the XX Bomber Command on 26 September 1944 dropping a total of 865 500# GP bombs through nine to ten-tenths cloud cover. The interpretation is based exclusively on fair to good reconnaissance photography flown by the 468th Bombardment Group, XX Bomber Command. Interpretation was made difficult by lack of strike photography and incomplete cover of the target to the north and west. The target had been attacked twice previously in daylight on 29 July 1944 and 8 September 1944.

No specific item of damage definitely attributable to the attack of 26 September 1944 was identified within the confines of the Showa Iron and Steel Works proper.

A total of 168 bombs or about 20% of the number dropped were found, nearly all of which fell in open ground. Several small houses and several roads received slight damage. What are thought to be Ceremonial Grounds located about 9000' south of the target may have suffered damage but cloud largely obscures the area.

Of the 168 bombs identified, 6 are seen to have fallen just west of the cooling ponds on the western edge of the Works and the remainder from 7000' - 13000' south, south-west, west and north-west of the target in 5 general groups of about 30-40 each.

REFERENCES: (1) Air Objective Folder No. 93.3, Mukden Area
(2) Damage Assessment Report No. 8 (Preliminary), XX Bomber Command.

WEIGHT OF ATTACK: 865 GP 500# AN-M-64 bombs (TNT filled) fused 0.1 secs. nose and 0.025 secs. tail.

PHOTOGRAPHY: 444th Bombardment Group, XX Bomber Command, Mission No. MR9, 27 September 1944, quality fair to good, scale approximately 1:14,000.

PREVIOUS PHOTO COVER: (1) F21 PRU, Mission No. 4M33, 4 August 1944, excellent quality, scale approximately 1:13,000.

(2) 40th Bombardment Group, XX Bomber Command, Mission No. MR4, 9 September 1944, quality good to excellent, scale approximately 1:14,000.

AIMING POINT: North-east end of the West-Central Coking Unit.

ANNEXES: (1) Annotated Print and Bomb Plot.

REMARKS: Full cover of the coke oven area was obtained but incomplete cover of the target was obtained to the north and west.

All numbers in parenthesis preceding statements under Details of Damage refer to corresponding numbers on the attached annotated print (Annex 1).

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DETAILS OF DAMAGE:

(1) A group of 6 craters were found in open land approximately 5200' west of the central batteries and just west of the cooling ponds on the edge of the Works.

(2) A group of 45 craters were found in open land approximately 7000' - 9000' south of the central coke batteries. What are thought to be Ceremonial Grounds was straddled and the Grounds may have suffered damage but the area is cloud obscured.

(3) A group of 36 craters were found in open land approximately 13000' south-east of the central batteries.

(4) A group of 38 craters were found in open land approximately 7000' east-south-east of the central batteries.

(5) A group of about 45 craters were found in open land approximately 10,000' east of the central batteries.

(6) A group of 8 craters were found in open land approximately 12,000' north-east of the central batteries.

STATUS OF WORKS:

a. South Coking Unit

Batteries 1 and 2 show no change. A crater near the base of the cooling tower marks a near miss of Mission 8 thought surely to have effected damage. The north end of Battery 4 is largely destroyed. Conveyors, pusher-track platforms, "hot-car" tracks and mains are still unrepaired.

b. West-Central Coking Unit

Battery 1 shows no change. Considerable clearing of wreckage was observed on Battery 2 completely destroyed on the previous mission. Battery 3 shows no change. The pusher-track platform and main serving Battery 4 appear partly rebuilt.

c. East-Central Unit

Batteries 1 and 2 show no change. Batteries 3,4 and 5 show repair work in progress. The conveyor serving Battery 5 is still unrepaired.

d. North Coking Unit

Battery 1 shows no change. Battery 2 shows further evidence of probable damage by a near miss. "Hot-car" tracks just west still appear to be in a damaged condition. Batteries 3 and 4 appear to be operating.

e. Coke By-Products Plant

This plant appears entirely dormant but clearing and repair work is in progress.

f. Rail Mill

Further sections of the roof have been removed and new roofing has been started.

g. Calcining Plant

'Squaring-off' of damaged areas preparatory to repair was noted.

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h. In other sections of the plant debris is being cleared and several largely destroyed warehouses and shops are being dismantled. Roads and trackage appear to have been largely restored.

James D. Garcia
JAMES D. GARCIA
Colonel, Air Corps,
Chief, Intelligence Section.

PREPARED BY: TARGET UNIT
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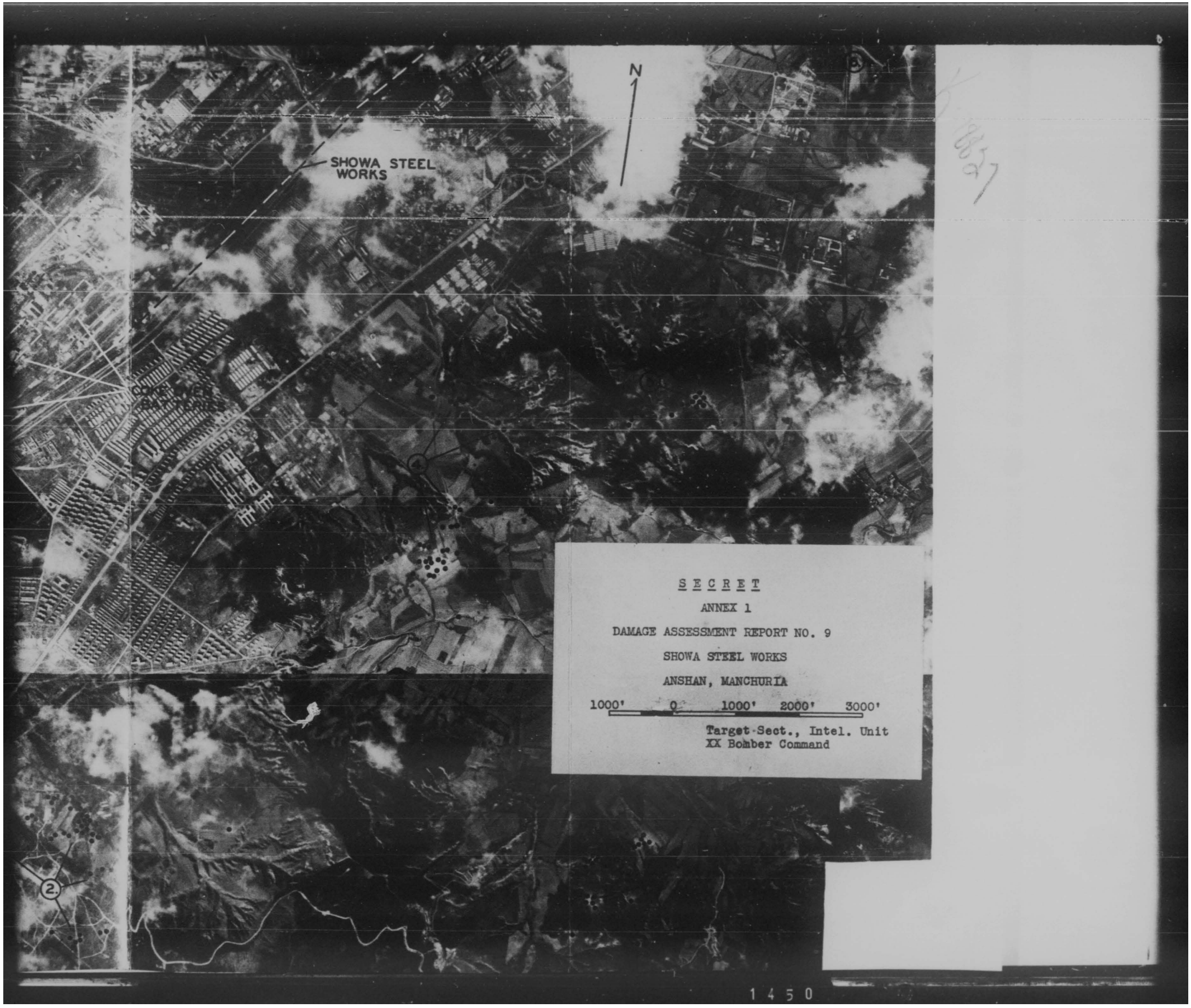


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# MILITARY INTELLIGENCE DIVISION

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### MILITARY ATTACHÉ REPORT

Country Reported On

Subject RED AIR RAIDS I.G. No.

Brief Descriptive Title

Source and Degree of Reliability:

Summarization of Report

When Required

In Comments on Current Events Enter Item Heading Here

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# MILITARY INTELLIGENCE DIVISION
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### MILITARY ATTACHÉ REPORT

Country Reported On

Subject (Brief Descriptive Title) EASTERN AIR COMMAND WEEKLY INTELLIGENCE SUMMARY NUMBER 5. I.G. No.

Source and Degree of Reliability:

K-77697

Summarization of Report (When Required)

(In Comments on Current Events Enter Item Headings Here)

Ground situation in Burma

Jap fighter attacks against B-29's analyzed

Enemy communications

Hutted camps and stores

Jap antiaircraft defenses

Enemy antiaircraft defenses to 24 Sept. '44

Lethal areas of HAA bursts

Flak on Hsenwi Bridge Mission, 11 Sept. '44

Reporting of AA fire and unusual bursts

B-29 crew members walk back through Japanese lines

Jap air order of battle

Japanese army air force strength

Ground situation in Burma

Analysis of Jap attacks on B-29

B-29 statistics on four maximum effort missions

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WALK-OUT REPORTS

B-29 COMBAT CREWS

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LIST OF REPORTS

| GROUP | AIRCRAFT | PILOT | DATE |
|---|---|---|---|
| 468th | #271 | Pattillo, J. L. | 7 June 1944 |
| 444th | #452 | Williams, J. F. | 7 August 1944 |
| 468th | #243 | Brown, H. R. | 11 August 1944 |
| 462nd | #359 | Brown, Stanley | 11 August 1944 |
| 468th | #356 | Winkler, E. E. | 25 August 1944 |
| 444th | #212 | Baker, Lee | 8 Sept 1944 |
| 40th | #222 | Renfro, W. G. | 11 Sept 1944 |

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*Auth: CO 468th *
*Date 25 Sept 44 *
*Initials JVP *
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468TH BOMBARDMENT GROUP

Office of the Intelligence Officer

REPORT OF CRASH OF A/C #6271

Airplane was on a flight transporting cargo, consisting of gasoline drums etc., from the base at B-1, India , to forward base at A-7 in China across the Hump on 7 June 44.

After approximately five hours flying and while over the mountains one-hundred miles south of destination at approximately 19,000' #2 engine suddenly began smoking from the upper cowl flaps. At this time, the power setting was 35 inches Hg and 2200 rpm. Approximately one minute later the smoking stopped and a severe oil leak developed, apparently in the nose section or thrust bearing. At the same time, #2 propeller over-revved to 2800 rpm. The engine was throttled immediately and the propeller governing switch was turned to the decrease rpm position but the over-reving contined to 3200 rpm. The air speed at this time was approximately 198 miles per hour. The propeller feathering switch was pushed immediately, without effect. No drop in nose oil pressure was observed when the propeller feathering switch was pushed. Several attempts were made to feather #2 engine without success. During this period the airplane was losing altitude steadily. The pilot then attempted to control the runaway engine by decreasing the air speed and lowering the wing flap to 25 degrees. After reducing air speed to 120 miles per hour, the propeller slowed down to approximately 1900 rpm. Full power of 2600 rpm, 47.5 inches HG was used on the other three engines in an attempt to maintain altitude at this slow speed.

At approximately 17,000', the pilot ordered all possible cargo to be salvoed. This was done with the exception of two gasoline drums which had been tied on the cat walk of the aft bombay. The gunners attempted to cut these drums loose and push them out the bombay without success. They became wedged against each other in such a manner that the rear bombay door could not be closed completely, remaining open approximately six inches. The forward bombay doors were closed.

The Navigator reported that the propeller dome and the nose section on #2 engine were becoming red hot. It appeared that the engine was ready to disintegrate. The plane was still over the mountains, just above the cloud layer and the exact location could not be definitely determined. The air speed was approximately 120 mile per hour, and the plane was descending at about 800' per minute. Not being sure of his exact position with relation to the mountains, the pilot



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ordered the crew to bail out. At this time practically all of the oil in #2 engine had been lost and the oil pressures on the nose and rear sections which had remained constant at their normal settings, began to drop and the oil temperature began to rise.

The loading list read as follows:

| | | | |
|---|---|---|---|
| Pilot | Major | J. L. Pattillo | 0-420937 |
| Co-Pilot | 2nd Lt. | G. O. Matthews | 0-807014 |
| Navigator | 1st Lt. | R. L. Cournoyer | 0-667142 |
| Bombardier | 2nd Lt. | D. V. Irby | 0-747015 |
| Engineer | F/O | R. M. Roberts | T-192787 |
| Senior Gun | Sgt | H. G. Brogdon | 34644473 |
| Radio | S/Sgt | T. M. Keegan | 12132951 |
| Left Gun | Sgt. | S. M. Klusovsky | 15332756 |
| Radar | 2nd Lt. | R. M. Humphrey | 0-864212 |
| Right Gun | Sgt. | W. H. Troy | 39021672 |
| Tail Gun | Sgt. | C. E. Frey | 39102498 |

After sending a distress signal and ascertaining their approximate position by D. R. the pilot ordered the crew to bail out. All elevenchutes were seen in the air floating to the ground. The plane crashed to the earth some distance away and was seen to explode. Photographs submitted with this report substantiate the statements of several crew members that the plane exploded on hitting the ground and was completely destroyed.

S/Sgt Keegan experienced some trouble with the prop wash of the plane as it spiraled past him to the ground. It nearly dumped the air out of his chute as it tipped him at an angle of nearly 60° but he managed to keep it straight. His story as given by him on interrogation from that point on reads as follows:

"Being down to 200', I saw rocks and a swift current below. I slipped my chute and hit on the rocks and bounced out into the river into water over my head. My chute was caught in the current and started to drag me downstream. The chute then snagged on some rocks and I then managed to wedge my body between two large rocks. I managed to unsnap the top snap of the chute and at the same time I lost my hold on the rocks and was dragged feet first, with my body below water, downstream. I then unstrapped one of my leg straps and slipped out of my chute. I then swam about ten yards to the shore. I lost my chute, jungle kit, and escape kit in the river. I rested for about ten minutes, then proceeded to a nearby farm house. I showed the natives my flag and gave them some of the money from my money belt, both paper and coin. They then took





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me to a school house where I was told to take off my wet clothing and was given dry clothes. Then they gave me something to eat. I then explained that I wanted to go to the other side of the river I could see Sgt. Klusovsky and Lt. Irby who were being carried by two Chinese. When the boat was ready to leave I heard someone calling and saw F/O Roberts on the side of a large hill in back of me, waving his pilot chute. I then got out of the boat and went after him. Both of us came back to the boat. He then told me that Major Pattillio had landed about one mile from him. We then got into the boat and went across the river where we met Sgt. Klusovsky and then the three of us started walking upstream. We walked about four miles, came to a house where a Chinese electrical engineer lived who could speak English. Here we met Lt. Irby, Sgt Brogdon and Sgt. Frey. There were then six in our party."

Lt. Cournoyer was also tossed around quite a bit by prop wash on the way down. His story from just before landing reads as follows:

"I looked down and saw landing was going to be in a river. Because it was rapid I pulled back the shroudlines and finally lighted on a sand beach a few feet from the river. I attempted to talk to natives in a boat by use of Ding-How, Blood Chit and sign language to get them to take me to the other side of the river. The natives finally understood but the ferry rope line broke down. I ate rice lunch with Chinese fishermen who did not accept CN or silver. I started up mountain to plane with aid of guide but after three minutes I heard shouts and discovered Lt. Humphreys on top of a 1000' cliff and he said to stay where I was, that he would be down. I put my chute in a boat. A native motioned to a village north on the river, where I met Lt. Humphreys. I tried the flag and it worked - a very enthusiastic reaction. I decided to wait till morning when all of a sudden Major Patillo walked into the village accompanied by natives. We located several Chinese in European dress who spoke a littlbe English but got along better writing. One Wu Po Jang invited all of us to stay with him at night. We walked for four hours from 6 to 10 over a path running along the edge of the river - got suspicious but checked with jungle kit compass and fly button compass and determined we were going north. We arrived, after a short boat ride, at a little town where he was the majistrate. We were told to expect more of our friends at his house tomorrow. We sleptin a school house next day. We ate dinner and made fast friends by burping with pleasure. We were accompanied by soldiers at every move. We were told the following day that our friends would not appear till the next day - got a little suspicious but later that night the other six did appear. After "bulling" found that Major Pattillo was last out







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of the nose and Sgt. Klusovsky was last at rear therefore we knew that the men who were lost had got out of the plane. The next morning we left by boat for Lo Shan."

On the evening of 9 June 1944, the nine survivors arrived by boat at Lo Shan and were escorted to the headquarters of General Han, commander of the Chinese garrison. They were then installed in several rooms on the top floor of a three story Chinese hotel located in the heart of the city not far from the garrison. The rooms were equipped with crude beds, chairs, wash stands and mirrors and appeared reasonably clean. The bed clothes were however not so clean and were found to have already been used.

Word of the arrival of nine men at Lo Shan was received at A-7 on the morning of 10 June and at 1300 a rescue party consisting of Lt. Trafton, Med. O. at A-7, Lt. Phelan, Intell O. at A-7, three enlisted men and a Chinese interpreter started out for Lo-Shan with a jeep, and an ambulance. A weapons carrier also went along carrying supplies of gasoline, oil, feed and blankets.

After a trip over typical Chinese dirt roads, the convoy arrived at Lo-Shan about 1630 and went to the headquarters of General Han after being checked in at Police Headquarters on reaching the outskirts of the city. The types and numbers of each vehicle were recorded on the local register. From the headquarters the Party was lead to the hotel where Major Pattillo and eight others had been quartered over night.

Medical examination by Lt. Trafton revealed that Sgt. Brogdon had suffered a severe back sprain, that Lt. Irby had a mild sprain of his right foot, and that S/Sgt. Keegan had multiple bruises and sprains. Several of the crew were suffering from mild cases of dysentery resulting from the Chinese diet of the last two days, but none were seriously ill.

Immediately after the medical examination, Lt. Phelan, conducted a preliminary interrogation designed to gain information as to the possible whereabouts of the two men who were still missing: Lt. Matthews, the co-pilot and Sgt Tidy, a gunner. As Major Pattillo and Sgt Klusovsky were the last out of the plane from the front and rear, respectively, it was conclusively shown that the missing men had left the plane. Reports of several crew members coincide on the point that all chutes had opened, as several men counted tenchutes in the air in addition to their own. One man falling nearest to the crashed plane is certain that none fell into the burning plane.





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By the time all the data was gathered it was getting dark and it was concluded that it would be fruitless to send out a search party until daybreak on the following day. At about that time a Chinese Officer arrived bearing written invitations to the entire group, crew and rescue party alike, to attend a banquet as guests of General Han. The invitations were addressed by name to all crew members, and in blank to recently arrived members of the rescue party.

Before accepting the invitations, arrangements were made through officers representing General Han, and persons representing the magistrate of Lo- Shan, that guards should be placed at the scene of the crash at once, and that natives in the area should be advised to be on the watch for the missing men. Plans for a rescue arty to leave at daybreak were completed and it was agreed that Major Pattillo with one of the other crew members, M/Sgt Silva and the Chinese interpreter, and representatives of the magistrate and General Han would make up the party. All but those crew members who were injured attended the banquet tendered by General Han at his headquarters which were located at the very top of a high hill overlooking the city. The garrison appeared to be well organized and the soldiers were alert and reasonably well equipped with the usual Chinese small arms.

The party was shown to General Han's inner office which was a room about 20 feet square finished with divans and chairs around three sides of the room, and two fine desks, highly lacquered and shining, set back to back before half open paper windows. The walls were decorated with Chinese maps and charts. The receiving line included General Han, two lesser generals, a Chinese woman about 40 years old who had graduated from Cornell University at Ithica, New York about 1930 and whose husband is now lecturing in the United States, and a Chinese school master also educated in the U. S.

Tea was served while the usual talk and discussion of the crash went on through the Chinese woman who acted as interpreter and hostess. General Han was interested and politely but not overly curious about B-29's and the part they were to play against Japan. After about twenty minutes, supper was announced, and the party adjourned to the dining hall, a large room about 80 x 30 feet through which the party had passed on the way to the office.

The table was set in European style with good table wear, china and glass wear. The meal consisted of many courses, mixed with the usual Chinese manner soup being a middle course, and a meat course coming last with desert in between. The courses included fish, chicken, duck, soup,



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glazed bread, ham and eggs and one or two courses the nature of which it was difficult to ascertain. The meal was featured by the serving of fine rice wine of a golden hue. Two boys did nothing but keep the tall stemmed glasses filled with the wine as soon as they were drained. General Han and one of his aides gave picturesque speeches of welcome, stressing Chinese-American friendship both during and after the war. The existence of England as a present ally or future friend was completely ignored, and England was not mentioned at any time during the entire evening. Major Pattillo responded on behalf of the guests, and made an excellent impression. Toasts were given honoring the Americans, the Chinese, each crew member, his wife, sweetheart, and children, any excuse for another drink. The dinner ended abruptly around nine o'clock as it appeared that the general had pressing business to attend to, probably his new bride who had not been present at the banquet.

After returning tothe hotel other Chinese Officers arrived to confirm arrangements for the morning search. A restless night was experienced by all, largely because of the unauthorized and unwelcome visitors in our beds. On the morning of June 11, Lts. Trafton and Phelan with seven crew members made the return trip by jeep and ambulance to A-7. (An offer by the rescue party to pay the hotel bill was declined, the answer being that it was taken care of by the magistrate who knew that we did not have enough money with us to pay the bill.)

Major Pattillo and his search party made the trip back to the scene of the crash and verified the fact that the plane and all confidential equipment had been destroyed in the crash. Photos attached to this report were taken at the scene by Major Pattillo. They arrived back at Lo-Shan on the evening of 13 June without having found any trace of the missing men.

On their arrival at Lo-Shan, they were told that a body had been found in the river about half way between Lo-Shan and the scene of the crash. Later investigation revealed that it was the body of Sgt. Tidy, one of the missing crew members. The body, badly bloated from the many hours in the water, showed head lacerations, death probably having been caused by drowning. A Chinese casket had been provided by the Chinese and the party returned to A-7 with the body.



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The following observations and suggestions were made by the crew members:

1. It was thought that the Chinese silk maps were not very accurate and were confusing.

2. The Pointie-Talkies met with varying success, not being understood by some of the Chinese.

3. The blood chits also met with varying success. They were not so successful with the local natives, but were very successful with the Chinese soldiers encountered in the area.

4. It was suggested that Mae Wests be worn over this country as the mountain rivers are swift and deep. (This suggestion has since been complied with, the wearing of Mae West's on the hump trips now being SOP in the 468th Bomb Gp.)

5. While the money was successful and probably helpful it would not have been absolutely essential to rescue in this particular area. Money was refused on some occasions.

/s/John V. Phelan
JOHN V. PHELAN,
CAptain, Air Corps,
Interrogating Officer.

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XX BOMBER COMMAND





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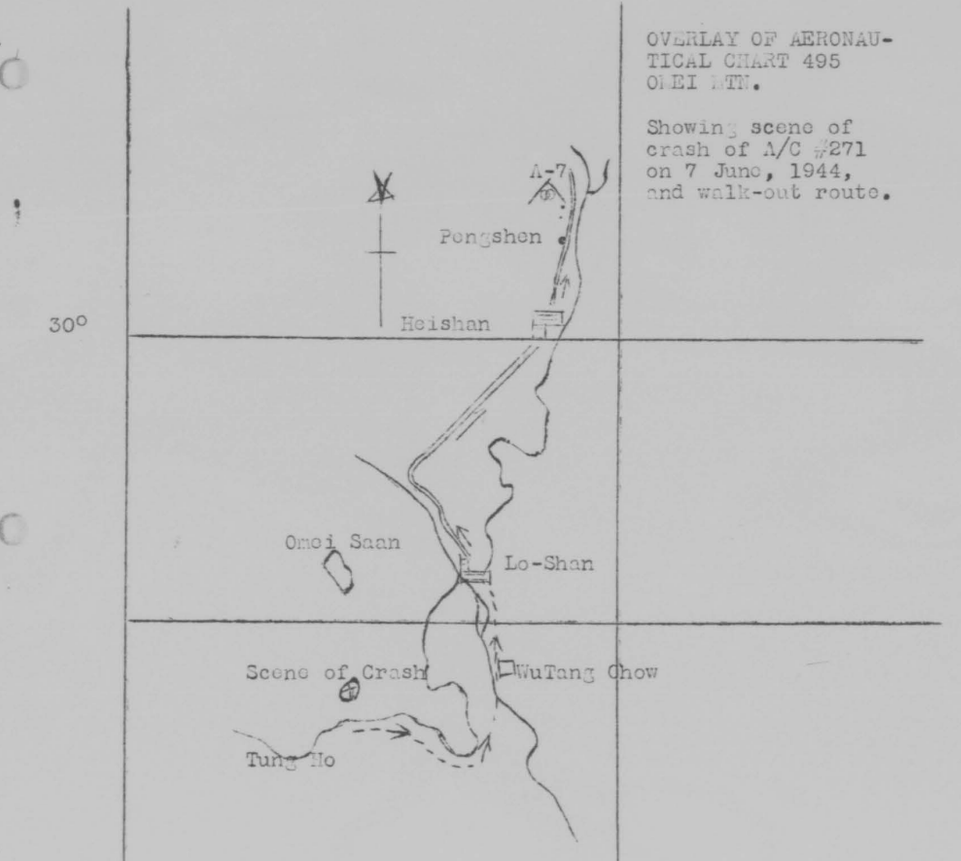
OVERLAY OF AERONAUTICAL CHART 495 OMEI MTN.

Showing scene of crash of A/C #271 on 7 June, 1944, and walk-out route.




ROUTE OUT

From Scene south across Tung Ho river, then east along trail and by river-boat to Wu-Tung Chow; then north by river-boat to Lo-Shan.

LEGEND

RIVERS ————

ROADS ═══

TRAILS — → - -

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* 444th Bomb Group*
* NSB *
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REPORT OF BAIL-OUT EXPERIENCES, CREW OF A/C NO. 6452, 7th AUGUST, 1944.

(In order to obtain maximum effect this report is written in the first person. The exact wordage of persons interviewed is used to the greatest extent possible, and continuity is maintained, however, it is not represented to be verbatim quotes.)

PERSONS ABOARD AIRCRAFT:

| | | | |
|---|---|---|---|
| Capt. | | J. F. Williams | Pilot |
| 1st Lt. | | R. V. Mays | Co-Pilot |
| 2nd Lt. | (x) | J. E. Addins | Navigator (x) |
| 2nd Lt. | | T. N. Fair | Bombardier |
| 2nd Lt. | | G. H. Lancaster | Flight Engineer |
| 2nd Lt. | | H. S. Liebman | Radar |
| S/Sgt. | | R. L. Whitton | Radio |
| S/Sgt. | | A. M. Lohman | Right Gunner |
| S/Sgt. | | R. R. Kolthoff | Senior Gunner |
| S/Sgt. | | J. B. Hoadrick | Left Gunner |
| S/Sgt. | | B. M. Warsinger | Tail Gunner |
| M/Sgt. | | C. R. Jackson | Crew Chief (Passenger) |
| Cpl. | (x) | T. S. Bingham | (Passenger) (x) |

(x) - Killed.

REPORT OF CAPT WILLIAMS, Pilot:

We made a normal take-off - for A-3 - at 0700 IST on 7 August. Soon after take-off we ran into bad weather so I climbed to 11,000'. We broke out of the weather at about 0830, and as we broke out #4 engine cut out. Tried to feather but could not. I alerted the crew for bail-out and began looking for a place to salvo the bombs. The countryside seemed to be well populated but soon found a river. Just at this time, however, #4 started running away, it was losing a lot of oil and then caught fire. The flames were reported by the right gunner and the co-pilot. I saw an airstrip and thought that I would try to land. But I couldn't let down for every time it was attempted the engine ran away, so at 0845 I ordered the crew to bail out. In the rear of the airplane the tail gunner went out first, then Cpl. Bingham, then the right gunner, the senior gunner, left gunner and then the radar officer. In the nose the crew chief, Sgt. Jackman, was first out. He was followed by the navigator, the bombardier, the engineer, then the co-pilot, and I went out soon after he had jumped.

I jumped at about 3500 or 4000 feet and didn't have anything with me but my parachute and money belt. Soon after I jumped I saw the airplane go into a cloud, and that's the last I saw of it. I landed in a dried-up



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| 2nd Lt. | | T. H. Fair | Bombardier |
| 2nd Lt. | | G. H. Lancaster | Flight Engineer |
| 2nd Lt. | | H. S. Liebman | Radar |
| S/Sgt. | | R. L. Whitton | Radio |
| S/Sgt. | | A. M. Lehman | Right Gunner |
| S/Sgt. | | R. R. Kolthoff | Senior Gunner |
| S/Sgt. | | J. B. Headrick | Left Gunner |
| S/Sgt. | | B. M. Warsinger | Tail Gunner |
| M/Sgt. | | C. R. Jackson | Crew Chief (Passenger) |
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rice paddy close to a village. There were some natives who saw my descent and as soon as I hit the ground I was promptly surrounded by a large crowd of natives who were waving big, half-moon shaped knives. I can't say just where it was that I came down but it was not far from a river and big lake and was about ten miles NW of Agartala. The situation with these natives didn't look so good to me so I threw my money belt out to them. This caused a big scramble and at the same time a lot of them were crowded around me picking at my clothes and the chute. While this was going on a middle-aged native came up, took me by the hand, and said in English, "Come with me." He took me to a school in the village; it turned out that this man was the schoolmaster. I told that I wanted to get to British or American authorities and he said that he would take me to a British airfield. There was a lot of talking going on, and in the meanwhile some natives brought in my parachute and what was left of the money belt. We then walked to another village, by a lake, and here I was provided with an Indian policeman, an interpreter, and a bearer. The four of us got into a boat and were taken to a point where a British ambulance was waiting. I paid another 14 rupees for the boat trip. The ambulance took me to Singerba, which is close to Agartala. Reached there about eight o'clock and stayed until noon the next day. We were all royally treated by the British; they didn't seem to be able to do enough for us. We took a C-47 from Agartala at noon the next day and returned directly to B-3.

REPORT OF LT. MAYS, CO-PILOT:

I jumped from about 5000' - had only my pistol, Pointie Talkie and money belt in addition to my chute. It was 0845, at a point about eight or ten miles north of Agartala. I came down on the roof of a hut in a native village but rolled off into a pile of straw and was not injured. Very soon I was surrounded by a group of natives who carried long knives. None of them could understand me but finally I found one who could speak just a little English and told him I wanted to get to civilization. He did not seem to understand this but when I asked him for the President he immediately got the head man of the village. The "President" talked good English, but he, like the natives, was very curious. Incidentally, all the natives seemed to be under the complete control of this head man and obeyed all of his instructions. The "President" took me to his house and very soon Lt. Lancaster was brought there also. The "President" was very slow about making any move to get us out, so we told him that he had better hurry or he wouldn't get paid. We then went to a boat and were taken south on the river to Singerba, a British fighter strip about six miles north of Agartala. The British cooperated with us in every respect. They extended every courtesy to us; even gave us clothes and whiskey. They also paid out some money to the natives who had brought us in. We reached Singerba about 2:30 PM, remained there until noon the next day, took a truck to Agartala and then came back to B-3 by C-47.







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REPORT OF LT. FAIR, BOMBARDIER:

I came down in the water and found that I couldn't get out of the chute, but I managed to swim with the chute on, and after I had been swimming for about five minutes a boat with two men in it came alongside and I was pulled into the boat. One of these men was a Muslim - he took me to his house right away. I was trying to explain that I wanted to get to the British when Lt. Liebman was brought in to the same place. The natives tried to get us to eat - but we wouldn't take anything except some banans. Finally we got into a boat, but when we mentioned going to the British this Muslim demanded money at once. In fact, they stopped the boat and would not go until we had paid them. Between the two of us we gave them 205 rupees. We soon joined up with the boat that Lt. Mays was in and landed at the same place. From this point on my experiences were the same as Lt. Mays.

REPORT OF LT. LANCASTER, FLIGHT ENGINEER:

I went out of the airplane at 0844. I came down in a rice paddy and was immediately surrounded by forty or fifty natives. They seemed to be friendly. I passed out cigarettes. None of them could speak English but they took me to a village. I was made to sit in a chair and all the natives gathered around in a circle. They wanted my parachute, but I wouldn't give it to them. Soon the president of the village came up. He could speak English and I told him I wanted to get to the British. We started out to another village, followed by a large crowd of natives, some of whom were carrying my equipment. The other village turned out to be the one that Lt. Mays was in, and from the time of my arrival there my story is the same as Lt. Mays'. The only way I could get my parachute and jungle kit back again was to buy it from the natives.

REPORT OF LT. LIEBMAN, RADAR OPERATOR:

I came down in the water near a boat with a single native in it who somehow hauled me into the boat. I was completely exhausted. Soon I was transferred to a larger boat and we headed toward shore, all the while collecting an "escort" of many other boats. Upon landing we walked to a village where the natives were very friendly. I don't know just where this village was but it was on the south side of the river. Finally the head man came up, but he couldn't speak English, and insisted that I eat something, but I wouldn't do it. About this time a Hurricane came over and buzzed the village. I waved to the plane and he dipped his wings in acknowledgment. Then I was taken to the village Lt. Fair was in and from that point on my experiences were the same as his.

REPORT OF SGT. JACKMAN, CREW CHIEF:

I was the first man out of the nose. I landed in the water and the chute dragged me into a patch of water lilies. My chute was about two-thirds off when I hit the water, and I think that it is a mistake to get that far out of the harness for I was dragged along with my head being



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pulled under the water and my feet out of it. I managed to keep afloat for about 20 minutes by manipulating around with the chute and among the lilies. At this time a boat with three natives in it came over and I swam over to it. The natives wanted money before they would let me in the boat; I gave them some and managed to get aboard without any help from them. My boat soon joined another one that Sgt. Warsinger was in and together we proceeded toward shore. Along the route we were approached by still another boat, in which was a very well-dressed English speaking native. This Indian seemed to be well educated and he was very curious about our movements and about us. He wanted to know where we came from, where we were going, when we had to bail out, what type of ship we were flying in, whether we were pilots or not, and other things like that. We didn't tell him anything. He wouldn't give us information about the location of the British airstrip; when he found out that we wouldn't answer his questions he just went on down the river. (Sgt Jackman was not able to give us any other information about this person; simply that he was well dressed in clean white duck shirt and trousers; that he appeared to be well educated.) After this Indian left us we proceeded to the boatmen's village; then walked to another boat and were taken to Singabel Landing, but we had to pay the natives before they would put us in there. We then went on to the British outpost, and had to pay the natives again there.

REPORT OF SGT. WARSINGER, TAIL GUNNER:

I was the first one out of the tail. I had considerable trouble getting out of my parachute; when I finally did, I set out to try to swim to shore. In about fifteen minutes two boats came along but the natives would not help me in - all they would do was to keep on saying "bakshoosh". I climbed into one of the boats anyway, without any help from them, and indicated that I wanted to get to shore. We soon joined up with the boat Sgt. Jackman was in, and he has told you about the well-dressed Indian who stopped us and asked all the questions. After this Indian pulled away from us we went on toward shore, but about fifty feet away from shore an English-speaking native climed in our boat and wouldn't let it proceed until we had given him money. After this we landed and went to their village. We got some bearers to carry our equipment and the English-speaking native led us back to the boat and then took us to Singabel landing. We then went to the British base, where we had to pay the natives the third time. Sgt. Jackman and I were the first to arrive at the British Base. It was shortly after noon.

REPORT OF SGT. HEADRICK, LEFT GUNNER:

I saw that I was going to land in open water so I unbuckled the chest strap and one leg strap before touching. I found that I could slip out from under the chute without much trouble and also that I could stand up in the water. Within a few minutes a boat came along and I climbed in. Soon after we started off I saw another chute in the distance but I couldn't make the boatmen go to it. Many more boats came up and joined with





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the one I was in, then they proceeded toward shore. Before reaching land, however, they stopped me and I had to pay them before they would put me ashore. They took me to a village and inside a hut, where I stayed until a native came who could speak broken English. He finally got a boat for me and we went to another village. I stayed at this village until Lt. Fair and Lt. Liebman came by, when I got in the boat with them. My experiences were the same as theirs from that time on.

REPORT OF SGT. WHITTON, RADIO OPERATOR:

I was third out of the nose and landed in water, the countryside all around being flooded. When I saw that I was going to come down in water, I unbuckled the chest strap, and after I was in the water I didn't have any trouble pulling my legs out of the leg straps. A boat came along in about five minutes and I got in it. We soon joined with another boat and Sgt. Kolthoff was aboard this one - unconscious. I got into that boat and we went immediately to shore and a village. The natives helped carry Sgt. Kolthoff and we took him to a hospital. There I made contact with the Indian Police who spoke good English. They wouldn't allow me to pay the bearers, but did so themselves. All of the natives at this village were very friendly and they did not molest any property, neither mine nor Sgt. Kolthoff's. Late in the afternoon I was taken to a larger village (this probably was Brahmanbaria) and arrangements were made to put me on a train going south. I thought I was going to Comilla, but about 10 o'clock that night I joined up with the rest of the crew at the British airstrip.

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468TH BOMBARDMENT GROUP (VF) AAF
OFFICE OF THE INTELLIGENCE OFFICER
APO #493, New York

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*Initials RHR *
*Date 25 Aug 44 *
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25 August 1944

INTERROGATION OF A/C #6243

The Navigator at interrogation stated that the last known position was 31°38'N - 115°18'E, at which point the radar went out. The DR ETA on primary target was 1553Z. Eliminating a 20 minute search, the A/C flew about an hour toward Japan beyond DR ETA, the reason being the LOP by moon shots. Taking into account the position of crash, the crew believed bombs were dropped 500 miles beyond PT, or that there was a strong headwind on the return trip. Four flashes were observed just after turnabout (at 1710Z) which crew believed to be a string of Photo Flash bombs; these flashes were about 10 to 15 miles south of course.

Bombs were dropped at 1710Z on what appeared to be an island with a single light showing. A large fire was observed near the light after bombs were dropped.

The only other ground observation was searchlights at 1538Z.

At 110045Z the crew bailed out at a point about 30 miles west of Changteh; position was approximately 29°10'N - 111°10'E. A/C was last seen in power glide at altitude of about 11,000', airspeed about 175 MPH, heading about 260°. At time of bail out there was a fuel pressure of 4 pounds in #1 engine; less than 30 gal of oil in #4, #3 was smoking, and practically no gas was left.

The Following Is A List Of The Crew Of A/C #6243

| | | | | | |
|---|---|---|---|---|---|
| Pilot | Major | Brown | Radio Op | Sgt. | Barto |
| Co-Pilot | Lt. | Goeringer | Radar Op | Sgt. | Nogle |
| Navigator | Lt. | Beach | Left Gun | Sgt. | Plant |
| Bombardier | Lt. | Stern | Right Gun | Sgt. | Owens |
| Engineer | F/O | Martin | Tail Gun | Sgt. | Nebeker |
| S/G | Sgt. | Chobot | | | |

All members of the crew met at Taoyuan, arriving in parties as indicated below:

Brown )
Goeringer) Landed close together and went to Chijahao
Owens )

Went together to Taoyuan; met remainder of crew there.

Chobot)
Plant ) Landed nearby & met Maj. Brown at Chijahao



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|---|---|---|
| Beach )<br>Nebeker) | Made contact &<br>went to Chow | |
| Martin)<br>Barto )<br>Mogle ) | Landed nearby & met<br>Lt. Beach at Chow | Went Together to<br>Taoyuan |
| Stern | | Met Crew at Taoyuan |

From Taoyuan the crew went to Yuanling where they met Major Housall and Lt. Ingram; thence by truck to Chih-chiang; thence by ATC to Kunming, Chabua, Calcuuta and B-1.

The Following Is A Detailed Description Of The Trip

Major Brown bailed out and landed without serious injury. Soon thereafter he met Goeringer and Owens, who had landed nearby without injury. Chinese peasants met them and after some explanation and the use of the Pointie-Talkie, the peasants understood that they wanted to go to town. They were taken to a house and given hot water to drink. They gave a ripped parachute to the peasants.

About 1430 they arrived in Chijahao and were taken to the city hall where they again were given hot water; food was prepared for them. One local Chinese spoke English and he told them their location. Sgt's Chobot and Plant had already arrived. They rested that afternoon and were served food that evening. All their crew members were present that evening except 2 who were contacted by telephone.

The following morning the five of them travelled by sampan down the river toward Taoyuan, where the Chinese army had arranged for the crew to meet. They arrived at the end of the boat trip at 1800 and reached Taoyuan by chair at 2030, where they met the rest of the crew.

Sgt. Chobot bailed out without injury. He showed his Chinese flag to a group of peasants, and they led him to Sgt Plant, who had broken a bone in his ankle. After wrapping his ankle, the two were carried to Chijahao where they met Major Brown and proceeded with him to Taoyuan.

Lt. Beach bailed out and landed in a rice paddy in the Chelong Hill area at 0750 China time. He showed his Chinese flag to a group of peasants. They took him to a house where some Chinese soldiers were stationed. He rested there for about an hour and met Nebeker.

Sgt. Nebeker's chute harness had slammed his pistol against his ribs when the chute opened, and he was injured slightly. When he landed he showed his Chinese flag to some farmers who approached. We had difficulty using the Pointie-Talkie until he found a peasant who could read. He made them understand that he wanted to go to the nearest troops. Three of them carried his equipment and he proceeded to the village where he met Lt. Beach. At the village there were many Chinese under arms but not in uniform.







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The two men went by chair to Chow, arriving there at 1900. There they met F/O Martin and Sgt.'s Barto and Mogle.

F/O Martin landed about 0800 China time. He showed his Chinese flag to the peasants and tried to locate someone who could speak English. He met Sgt. Barto almost immediately. They proceeded to a nearby town and found a man who could read. He arranged for chairs for them. They met Sgt. Mogle there. He had landed about 7 miles out of this village and had been lead there; he had been unable to use his Pointi-Talkie but had used his flag. The three of them started for Chow by chair and arrived there about 1500. They went to a Chinese garrison and were served eggs. Their queries as to the proximity of Jap lines were greeted with laughter. The soldiers appeared to be in charge; they cleared the streets ahead of the group and generally ran the town. They went to the "city hall", found a Chinese who could speak English and contacted Maj. Brown at Chijaho. They were not allowed to pay for meals or quarters, but had to give their names everywhere they went; their impression is that the Chinese government would use their names in billing the U.S. for the services rendered. The Chinese Army made all arrangements.

The group of five left by chair at 0800 the following morning for Taoyuan, arriving there at 1245. All the city officials were out to meet them. There was a parade and a profusion of firecrackers. They met Lt. Stern at the mission and all went to the Young Men's Society Of Three Principles (apparently similar to Y.M.C.A.) There they met Major Brown at 2000 on the 12th.

The crew reported that some of the people at Taoyuan looked as if they had been tortured; that during a 2 weeks occupation by the Japs sometime earlier in the year the public buildings had been razed and burned, but are now being rebuilt.

Lt. Stern landed at 0752 in a rice paddy. He met a peasant and showed him the flag but he didn't seem to understand. He finally located a man who took him to a Chinese mission. There a chair and bearers were provided and he was taken into a village. He went to the city hall, talked to a local official who took his name and told him there were more Americans in the area. He went on to a Chinese garrison on the bank of a river where he was offered food and given boiled water. A Chinese officer gave him his horse, a guide and coolies, and he headed for the local army headquarters. When he arrived there late that afternoon, a room was ready for him; he was served food. He called Maj. Brown that night. After breakfast the next morning he got on another horse and with a Chinese Captain for a guide proceeded to Taoyuan. There he met the rest of the crew at the Catholic mission. He had been given an identification card by Chinese Army Hq, showing him to be an American, which he still has in his possession. The entire crew was well treated at Taoyuan; Mr. Wong, the local magistrate was very considerate. Medical attention was provided for Plant's ankle and Webster's bruised ribs.







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At 0930 on the morning of the 13th the crew left Taoyuan by chair for Yuanling; Mr. Yen, Secretary of the Young Men's Society, accompanied them as guide and interpreter. About 20 soldiers of the Chinese 18th Division accompanied them; the soldiers were armed with automatic rifles, and they stood constant guard. That night the party stayed at Chang-Chia-I; they were well fed - eggs, rice, chicken and pork. They left the following morning. During the day they heard machine gun and light mortar shell fire; they were told that it was maneuvers, but later heard that it was an engagement with bandits. They spent the night in an inn at Hsin-Tien-I.

The group left the following morning in the rain and reached the Catholic mission at Yuanling at 1745 on the 15th where they met Maj. Housell and Lt. Ingram and the truck from Chih-Chiang. The sisters prepared an excellent dinner. There were many missions at Yuanling and a number of schools and churches. They spent the night there. Plant and Nebeker received medical attention again.

They left the following morning by truck and arrived at Chih-chiang about 1400 on the 16th. There was a CACW base at Chih-chiang. An ATC C-47 picked them up and took them to Kunming. They remained there over night and after a weather delay took off for Chabua on orders cut at Kunming.

From Chabua they went TC to Calcutta, then to B-1.

(1) Pointie-Talkies were excellent, but crews should be cautioned that not all Chinese can read Chinese. Chinese flags were generally good.

(2) Jungle kits are good and the addition of sox, etc, is excellent. Suggest that insect powder be added.

(3) For information it was reported that Chinese soldiers were rough with Chinese civilians, forcing them to drop their work and carry chairs and the crews personal equipment.

RUSH E. RICORD,
1st Lt., Air Corps,
Interrogating Officer.

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STATEMENT CONCERNING FORCED LANDING OF B-29 AIRPLANE NO. 42-6359

13 August 1944

1. On 10 August 1944 at 1611 B-29 #42-6359 took off from Station A-5 on an official bombing mission. The target was Nagasaki, Japan. I was co-pilot of the airplane, having replaced the regular co-pilot for this particular mission. The pilot was Captain Stanley Brown. The remaining passengers were regular members of Captain Brown's crew. I, being Commanding Officer of the 462nd Bombardment Group, Advanced Echelon, had never been a regular member of a combat crew, and was taking the flight by permission of the Commanding Officer, 771st Bombardment Squadron.

2. Approximately two and one half hours out on course, the pilot was informed that the radar was completely inoperative. Captain Brown mentioned this to me and stated that he was going to continue to the target.

3. The weather was very bad and we were on instruments approximately five and one half hours of the seven hour flight to the target. To the best of my knowledge the navigator was able to get only one pin point during the entire route to the target. This was done about two hours after leaving Station A-5. From time to time we would break out of the weather but would go back on instruments before the navigator could get a star shot. I believe that he was able to get two shots during the route out. This was done shortly before reaching the turning point which was slightly south of the islandof Saishu, in the Yellow Sea. The navigator however seemed dissatisfied with these shots and so stated.

4. Our turning point was reached entirely by dead-reckoning navigation, and there was no method of determining whether or not we turned at the proper point or not. However, the pilot told the navigator he would turn on the order of the navigator, and did so.

5. Shortly before reaching the turning point and while we were at about 12,000, the engineer informed the pilot that something had happened to the fuel transfer system and that he was unable to transfer any more fuel. (He had transferred before this). The decision of the pilot was to continue to the target, realizing that if he were unable to transfer any more fuel, he would be unable to return to Station A-5. However, approximately thirty minutes out from the initial point the engineer informed the pilot that the fuel transfer system was again operating. We climbed to 17,000 feet.

6. The initial point was reached by dead-reckoning navigation. The weather had cleared over this area, but the navigator stated that we should turn into our bomb run upon his dead-reckoning calculations



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due to the fact that too much time would be wasted taking shots at this moment. The pilot realizing that the navigator was formerly unable to figure out his shots, agreed to this decision and turned in for the bomb run.

7. We reached land at approximately the proper time according to the field order and target charts. It was the belief of the pilot that the target should be lighted by fires at this time. No fires were seen, however, and only one or two lights were observed. Due to the fact that there was about 5/10 clouds under us, it was impossible to distinguish any definite plan of coast line under us. We turned south from our heading of 38° in hopes we would spot some lights or fires, but none were seen. After approximately ten minutes on a southerly course over land, we turned north again, assuming we may be south of the target. We flew north approximately fifteen minutes without seeing fires or lights. The pilot at this time asked my opinion for the first time as to what he should do. I stated that it was my opinion that we must make a decision immediately as to whether we would continue our search for the target, or drop our bombs and return. The gunners had reported seeing night fighters (no more than five total) twice. The pilots decision was to drop the bombs and return. It is my belief that we dropped our bombs over land.

8. One point I believe should be mentioned. During our search for the target, the navigator called the pilot three times and asked that we discontinue our search for the target and go home as he was completey lost and had no idea where we were.

9. We took up a heading of 270°, and flew for approximately 45 minutes with a broken overcast and undercast. During this time the navigator with the help of the bombardier took at least three or four star shots but was completely unable to figure our position. After 45 minutes, we went on instruments again and except for occasional breaks, flew instruments until daylight. We left the target area at 2405. There was a great deal of thunderstorm activity and the turbulence was severe in many instances. Shortly after daylight we broke out and flew over a solid overcast for about one hour and fifteen minutes at which time we hit CAVU weather over mountains which were unrecognizable to me. During the four hours of instruments enroute away from the target, the navigator seemed to have gained confidence and reported our position in longitude but stated he did not know our position to the right or left of our course. However, he stated we were within a 150 mile channel of latitude to our course.

10. At the moment we were able to see the ground both the navigator and the bombardier began attempting navigation by pilotage. Both the pilot and I joined them. At about 0530 we contacted Station A-1 and received a "DF" of 230° and took up this course. We were over mountainous area and we still were unable to identify our position on the map.





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11. At 0600 the pilot asked the engineer how much flying time remained and the engineer stated one hour. At this time we hit the Yellow River Valley and established what we believed to be our position which was approximately 450 miles NE of the Chengtu area. We also passed over a field at about this time. About ten minutes later we sighted another strip which was smaller than the first.

12. Approximating we were very near Japanese territory the pilot decided that in the event we were forced to land we would land on the strip fartherest west, which was the smallest, and was the field on which we did land later. The first field we sighted proved to be a Japanese airfield.

13. At 0710 the pilot stated that we would hold our course of 230° for about fifteen minutes more at which time we would return and land on the small strip in the event he saw no hope of reaching another field farther to the southwest. This decision we followed and landed at 0645 hours.

14. Prior to landing, the pilot called allmembers of the crew and gave the following instructons. "We are forced to land due to shortage of fuel. We believe we are just past the Japanese lines, but we are not certain. All gunners man the guns at all times. Upon landing we will roll to the end of the runway, turn around, and set everything for take-off and wait to see what happens. If we are attacked by Japanese, we will man the guns and take-off, fly as far as possible southwest and bail-out".

15. The strip was wide and smooth and appeared to be serviceable. Upon touching the ground, this proved true and the airplane rolled easily down the runway in the center for a distance. Then, however, the airplane began to hit soft spots on one side and the other. Approximately half the distance of our intended roll the left wheel hit a very soft spot and sank.

16. All the crew stood by their stations as the pilot and I observed the coolies working in the fields. A few of them ran to the edge of the strip but would come no farther. The rest worked on normally in the fields. Finally Captain Brown and I alighted from the plane and approached the coolies at the edge of the runway. The rest of the crew stood by the plane.

17. For approximately one hour we attempted to gain some idea from the coolies as to where we were and whether or not we were in friendly or Japanese territory. We found no one who could speak English and the use of "pointie-talkie" was extremely slow. We were finally able to assume we were in friendly territory, and instructed the radio operator to send a message reporting our landing in friendly territory out of gas and stuck in the mud. We could not state our location.



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18. At about 0900, 11 August we were able to make the coolies understand that we wanted to contact the local authorities. Captain Brown and I departed with the coolies leaving the remainder of the crew, three officers and six enlisted men, with the airplane. We still had no idea whether or not we were open to Japanese attack by ground or air. The coolies at the time seemed reluctant to get anything started.

19. The coolies led us to a spot about a mile from the runway and told us to wait. In a short time they brought a field telephone and hooked on to a telephone line. At about 1030, and after a great deal of difficulty with communications, the Chinese language and the telephone, we contacted a Sergeant Chambers, at Sian, approximately 50 miles to the West, and as we learned later, a staging field for American and Chinese fighters and light bombardment airplanes. We told Sergeant Chambers to relay our position back to our Headquarters and agreed we would contact him every half hour if possible as to developments. He informed us he could get us gasoline and that we should try to get the local authorities to get the airplane out of the mud. He also stated that we should stand by this telephone until he contacted us again. We did this and learned he was arranging for fighter cover and we should keep in contact with him at all times possible.

20. At about 1130 or 1200 a Chinese truck arrived with a Chinese officer who could not speak English. We gathered from him that he would take us to the Chinese Headquarters where we would be fed and able to get help to get our airplane out of the mud.

21. We drove to the airplane where we picked up three more members of the crew and left two officers and four enlisted men with the airplane. The Chinese officer also posted about ten Chinese guards on the area. A message was not sent at this time due to the fact that (1) we did not know how much help we could get or what facilities they had for moving the airplane. (2) The Sergeant Chambers at Sian had sent our position and condition. (3) We were still not certain how vulnerable to attack we were. Had we sent a message at this time we would not have been able to add anything to the information we had already sent.

22. We departed from the airplane in the truck at approximately 1230 enroute to the Chinese Headquarters. It was about ten or twelve miles over rough roads, and the truck was stopped twice while the Chinese carried on their various business conversations. We arrived at the Chinese Headquarters at about 1330.

23. Captain Brown immediately contacted Sergeant Chambers at Sian and informed him that we believed we could get help now and would he contact our Headquarters and arrange for the fuel. To this he agreed.

24. By this time there had appeared a Captain Ma, the Chinese Captain of the guard for this area. This officer spoke a very limited







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amount of English. Through him we were able to arrang for (1) Camouflaging the airplane (2) A telephone call to Sian authorities with arrangements to secure jacks, railroad ties, rock for strengthening the runway, and men and trucks to pull the airplane out of the mud. (3) A place for the crew to be fed and billeted.

25. Captain Ma assured us that allthese arrangements would be made and that we would return to the airplane at about 1600. He then left us. By this time it was about 1430. We had been given lunch.

26. At about 1530 Captain Ma had not returned and I could not find out where he was. I was finally able to get a truck and a squad of soldiers to return to the airplane. Just prior to our departure I was called to the telephone and speaking with an unidentified American pursuit pilot from Sian ( I could not understand his name) I was informed that the plane had been strafed by Japanese fighters. I departed for the plane immediately leaving Captain Brown to further arrangements with the Chinese.

27. Enroute to the airplane, I was met by two members of the crew in another truck. They informed me that the airplane had been strafed, but did not state the damage. They had departed the airplane hurridly, bringing most of the removable equipment with them. They had left four members of the crew at a position near the plane. Captain Ma then informed me that it was dangerous to go near the airplane and that the Japanese bombers were at that time only a short distance away enroute to bomb the plane.

28. I asked the driver of my truck to take me to the airplane as I wanted to determine its condition as soon as possible. We agreed and we departed enroute. Upon arrival at the airplane I was unable to find the crew but they, I learned later observed me from a cornfield approximately 400 yeards away. I determined what damage I could observe and crawled through the airplane to find out what other loose equipment I could remove. I thought this necessary due to the danger of the airplane being fired by strafing or bombed at any moment. I did not find any removable equipment that had not already been removed by the crew.

29. While I was in the airplane my Chinese friends started shouting at me, and at this moment I heard airplane motors. I left the plane and got on the truck which moved to the edge of the field as three unidentified fighters flew over the plane. I was in the cab of the truck and could not see them plainly. When we arrived at the end of the field I noticed that one Chinese truck had been left near the plane. (This truck was there upon our arrival, out of gas) We returned to the plane and toved the abandoned truck away. Enroute to Chinese Headquarters I met Captain Brown and a few more members of the crew in another truck and returned to the airplane with them. We again examined the plane for damage and picked up the remainder of the crew who had appeared on the runway.





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30. By this time it was dark so we left one officer and one enlisted man near the plane as guards with instructions to destroy the airplane in the event that it seemed certain to fall into enemy hands during the night. The Chinese had stated that this was possible. The Chinese authorities had arranged for 500 soldiers to guard the airplane that night. With this arrangement completed, we departed for the Headquarters to send a message (the radio in the plane was strafed) to A-1 as to damage of plane. We sent the message stating damage and parts needed for repair and retired about 2300.

31. At approximately 2430 that night, Chinese authorities from Sian arrived with jacks, railroad ties, rock and other equipment to remove the plane from the mud. They started work immediately. This was the first possible time that work could have begun to get the airplane out of the mud.

32. On the morning of 12 August we went to the plane and began work again with the Chinese. We got the airplane completely jacked up and a ramp built out of rock to tow the airplane out. At about 1400, Major Massey arrived from A-1 in a Beechcraft with a Chinese pilot he had secured to bring him from Sian. It was decided that I should depart for A-1 and render a full report to Colonel Monteith. Major Massey remained at the airplane with the crew and I returned, reporting to Colonel Monteith upon my arrival at A-1.

33. If my opinion is desired, it is as follows. It was a matter of poor navigation on the part of the navigator and the inability of any member of the crew, due to their lack of knowledge of celestial navigation, to assist him, and no radar. During no appreciable time throughout the entire mission until we reached the Yellow River Valley, was there any possible chance to do pilotage. The metro-winds as given the navigator in the briefing were in error, and due to the strong headwinds on the return trip the airplane did not cover the originally estimated number of miles in the given number of hours of gasoline aboard. It is my belief that the entire crew did everything within their power to expedite the fly-away of the airplane from the point of landing and to protect it from enemy action.

/s/Edward J. Potter,
EDWARD J. POTTER,
Lt. Colonel, A. C.,

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XX Bomber Command -6-

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S E C R E T

792ND BOMBARDMENT SQUADRON
Office of the Intelligence Officer
APO 493, New York, N.Y.

18 September 44

SUBJECT: Report of Captain E. E. Winkler.(Pilot of A/C #356)
(Date of accident - 25 August 44)
TO : Commanding Officer, 468th Bomb Group, APO 493,
ATTN: Group S-2.

1. The following is the report of Capt. E. E. Winkler from the time of bailout till his return to A-7.

"I bailed out about 0700 at 17,500'. I was knocked out just after pulling my rip cord. I had my canteen in my left hand and believe it hit me on the head when the chute opened. When I came to I was sitting on the ground. I called out to F/O Thompson who answered me. Instantly I heard some Chinese voices. I knew I was in Lolo country and my first instinct was to hide. Looking around I saw six natives coming toward me line abreast about four feet apart. I yelled 'Ding Hoa' and held upmy thumb but it made no impression on them. I called to Thompson and told him that I was going with these fellows and he didn't have to show hamself if he didn't want to. I went back and got my parachute. We started down the road and as we came around a bend we came upon F/O Thompson standing in the path. I talked with Thompson and neither of us were sure whether these people were Lolos or not. Natives were very curious. They opened my jungle kit several times and I had to close it and try to tell them not to open it. As we walked on, the native carrying my parachute got far out in front of everyone and finally started away in a dead run. I never saw him again. We arrived at a village at about 1000. There we met the real Lolos. They were much larger than the Chinese, much more clean cut and they usually wear their hair tied in a knot on top. Natives or Lolo slaves by waving etc. told us that there were three more men coming down the hill into the town. We went out to meet them. Sgt Griffith came in on a donkey. He had a sprained ankle. Lt. Stover and Hardin were walking. We came back into town. While we we were standing around talking we noticed a Lolo in a bright blue uniform talking to other Lolos apparently about us. We found one man who could read the Pointie-Talkie. We asked him how far it was to Lo-Shan. He said that Lo-Shan was over the mountain about two or three days away. Lt. Stover had a cut chin caused by his gun flying up and hitting him in the face



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when his parachute opened. We redressed his cut,and decided to try to walk to Lo-Shan. Sgt Griffith was still on the donkey so we tried to persuade the owner to go with us. He refused and we gave him some money and still he refused to go or to sell the donkey. Finally I pushed him along forcibly and we started for the river near the village. About 1400 we met a guerrilla chief and a Chinese soldier. The guerrilla chief was dressed in white cloth and was about 25 years old. He took us to a Chinese who could speak English. The guerrilla chief told us he had been sent to get us and was going to take us to his village. We had no food so we ate raw corn from the fields enroute. About 1930 we reached the guerrilla chief's house, which he called Army Headquarters. It was a standard Chinese house, one large room in which the livestock were kept on one side and beds for the members of the household on the other side. We slept in a small anteroom and the mosquitoes were very bad. In our small room was a wooden coffin which contained the body of a relative of the guerrilla chief. The relative had been dead two years and later it was explained to methat no burial was accomplished because the chief had not found a suitable place for burial. The next morning the father of the chief and several other natives set out to find Sgt Stone and Schriner who were in the hands of the Lolos on the other side of the mountain. They borrowed our knives. At 1800 that evening ex-General Yung, two officer gendarmes and 12 enlisted Chinese soldiers arrived. The people of the village paid him great respect. Some would kneel down in front of him and kiss the ground. He took out a handful of bills and gave money away to the natives. The General was very polite and kind to us. He brought us hard boiled eggs, chicken etc. They cooked the chicken head, entrails and all. It wasn't very tasty but at least it was food. Great crowds came to see us the next day. The General was always out there to greet them. He gave them some kind of a political speech. There must have been at least a thousand people that day to view us. They were all very curious and were very interested in the fact that we had hair on our arms. All the time I had been laboring under the delusion that the officer gendarmes were the people to talk to but I found out later that the General was the man to take my troubles to. From the time the General arrived till the time we lefthim at Fulin there was a constant guard kept around us even at night, when we slept. The buildings had cement floors which served as our mattress. It was toomuch for Lt. Stover and F/O Thompson so they went outside and went to sleep in the hayloft. The next morning when theyawoke there were at least eight Lolos asleep all over them. One Lolo had crawled in between the two officers and was snoring away. Lt. Stover and F/O Thompson slept inside after that. Later in the afternoon of the third day Sgt Stone and Sgt Schriner were brought in. Sgt Stone was in pretty bad condition; his rib was broken and hip skinned and the inside of his leg was skinned from the thigh all the way to his ankle. Sgt Stone's leg caught on the escape hatch as he was leaving



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the airplane. The General said that we would leave in the morning for Fulin. We didn't sleep well but awoke the next morning in good spirits at the prospect of going on to Fulin. Sgt Stone had been in constant pain all that night. I wnated to get him to a doctor. Mr. Wong, a Lieutenant gendarme in Fulin, came to me and said that we would not leave today, but tomorrow. I became pretty disgusted and wanted to get the two injured men to a doctor and everybody else had the "G.I.'s". He said that many people were coming in to see us. I didn't know until later that the General had ordered 500 Lolos to come and see us that day. I went to Mr. Lee Yeng Ho, a gendarme who could speak a little English and told him that if we didn't leave that day, the General would get into serious trouble with our government. It made no impression on them so we packed our things and started down the road carrying Sgt Stone and Griffith. Mr. Wong came up and told us that the General had changed his mind and that we would leave after breakfast. We left about 0800 and soon reached a river with a very strong current which at times was as wide as the Mississippi. We had to ford the stream at least 10 times. Our journey of 10 miles took 11 hours. On the way we stopped at a house belonging to a friend of the General. There we were given eggs, pears and some walnuts. We reached Fulin about darkness. It was a mile from the river to the city so the General had horses and sedan chairs waiting for us. On the way to the city, Lt. Hardin's horse became a little friskey and threw him to the ground. Lt. Hardin walked the rest of the way. We were taken to the General's house where we spent out time until the arrival of Col. DeFass Jr. from Chungking. There were in the meantime several personal incidents such as Lt. Hardin's birthday. The General broke out some of his best wine and needless to say a good time was had by all. Nothing else of importance happened."

/s/George J. Steinmetz
GEORGE J. STEINMETZ,
Captain, Air Corps,
Intelligence Officer.

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* Date 15 Sept 44 *
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HEADQUARTERS 444TH BOMBARDMENT GROUP
Office of the Intelligence Officer
APO 215

15 September 44

Experience of crew of Airplane 42-6212 that was Crash landed on 8 Sept 44.

In the absence of Captain Lee Baker, airplane commander of plane 42-6212 who has been requested by higher headquarters to remain at A-3 in order to assist in the salvaging of his plane, the preliminary interrogation submitted herein represents the combined remarks of 2nd Lt. Ray Palmer, navigator and 2nd Lt. Jerome Eigenberger, bombardier.

Due to a malfunction of the fuel transfer system on returning from the Anshan mission on 8 September 1944 at 0945Z plane 42-6212 was forced to crash land in the Wei river bed 50 miles due west of Hsian and 4 miles north of Chowchih.

The crash landing was accomplished with wheels up at a point in the river bed about 2 miles wide. The composition of the bed was about 7/10 sand and 3/10 water which helped no end in effecting a landing that only bent the props of three of the four engines. The front bomb bay doors were bent inward as the plane slithered through the mud and the earthen elements richocheting against the forward pressure bulk head doors forced the latter to burst open and showered the navigator with resultant silt. Crew members had assumed their normal ditching positions.

Just prior to crash landing a message was sent through the air control net giving the exact coordinates where the plane was going down. The navigator knew they were in the Hsian area and that an emergency field was located there, however due to the haze and the fact that the malfunction was discovered just a few minutes before landing it was impossible to spot the field. As it turned out later, the plane might have been destroyed had it landed there because Hsian airfield was bombed on the nights of September 10th and 11th by 8 Jap planes with effective help of enemy agents who by use of flares pinpointed not only the airfield but also the bomb shelter. Luckily the 30 pound frags and 100 or 300 pound demolition bombs used by the enemy only scarred the runway and landed about 10 feet from the bomb shelter.

The term "airfield" is used advisedly since the alleged 3500 foot runway, was overgrown with weeds ranging from 10 inches to 2 feet in height, and furthermore it was impossible to tell where the runway began and ended. In a matter of just a few moments after the plane had landed, there were upwards of 100 Chinese soldiers around the plane acting as guard.



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The terrain was of a very fertile type with cultivated fields surrounding the country side.

Having made sure that everything of a secret or classified nature was secure, Captain Baker the pilot and Lt. Paisley, Co-Pilot went to Chowchih about 4 miles away in order to telephone Hsian. The other crew members slept within 20 feet of the plane having satisfied their innards with "K" rations. Lt. Eigenberger was awakened during the night by a tugging at his feet and found the Chinese soldiers placing straw under him as they did to the other crew members and also supplied blankets for their warmth and comfort. It was very cold but to preclude the possibility of letting the Japs know where they were, they did not light a fire.

The following day, September 9th, all but two of the crew members went to Chowchih to join Captain Baker and Lt. Paisley. Before leaving, Lieutenants Eigenberger and Palmer went through the plane and removed all classified material and equipment including target folders, bomb sight, and radar equipment and took it with them. Anything of importance otherwise, was either destroyed or so disassembled that would be of no value to the enemy.

On reaching Chowchih the crew members were domiciled with a Roman Catholic Bishop by name Chao, who though ordained in Rome and who spoke Latin, French, German and Chinese fluently could not speak English. According to Lieutenants Eigenberger and Palmer this was more than made up by the Bishop's hospitality. Each crew member was given a spotless bed room replete with a bed and mattress. They remained there for 4 nights and each meal had a minimum of 4 courses with excellent food. Not the least of the condiments was a fine 6 year old wine made by the Bishop and to whose health the crew members "gombayed" several times.

Captain Baker in the meantime had consulted the American unit at Hsian which comprosed 5 enlisted men who stated they would secure assistance as soon as possible. A Chinese Colonel Ma Meng came up from Hsian and rendered invaluable assistance to Captain Baker. The Colonel was on the staff of General Hu, who succeeded to the Command of three Chinese armies when Generallisimo Chang Kai Chek vacated the post. Colonel Ma spoke English fluently and having supervised a similar operation of a B-29 that crash landed nearer the Jap lines recently, was able to most successfully co rdinate the efforts of all concerned. The Chinese reported that a reconnaissance plane flew over #222. The plane had been camouflaged with straw to the extent that the outline of the wing assembly was diffused. On the third day, September 10th, Captain Baker and S/Sgt McCown, the radio operator went to Hsian by train in order to try and contact either A-1 or A-3 by telephone. The remaining crew members went back to the plane and stayed there for the balance of the day. The Chinese had a cordon of over 200 soldiers around the plane and it was necessary for the crew members to get permission of the local unit Commander before even they were allowed near the plane.





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The Chinese in the meantime had completed a road from the plane to the railroad, a distance of five miles in two days time which though crude was truly a remarkable achievement.

On the fourth day, September 11, 1944 part of the day was utilized by going around to the various schools in Chowchih where the crew members thanked the people for their hospitality and also played basketball with the Chinese soldiers. Two crew members always guarded the plane.

On September 12th all crew members with the exception of Sergeants McCown and Esposito left for Hsian. Major Malley of A-1 had flown up and having determined that the plane could not be flown out, directed that it be salvaged.

On September 13th a C-47 picked up the crew members at Hsian and returned to A-3 from which point 4 crew members flew back to B-3 today.

If any additional information is gathered from the remaining crew members yet to return to B-3, a supplemental statement will be forwarded from this office.

/s/E. B. Sullivan,
E. B. SULLIVAN,
Captain, Air Corps,
Asst Intelligence C.

HEADQUARTERS
XX BOMBER COMMAND
APO 493

MEMORANDUM: 21 September 1944

TO : Colonel Skaer

CONTENT ON PAR. 5

Hsian (town of Sian) is listed as a dry weather fighter field with a grass runway of 3,000' - 4,000'. Areport (verbal) from the 1st Air Transport Squadron stated that C-46's operate from and to this field. The grass is kept well trimmed at all times and the only obstruction is a dyke on the s/w end of the field. Coordinates: 34°11'N - 108°54'E.

Before crash landing in the river the Aircraft Control Center received only the following report from B-29 #6312: "Crash landing in river. We know where we are". This was at 0950Z, just a very few minutes before crash landing. Fortunately we were able to contact them after the crash.

J. K. CARR,
Major, Air Corps,
Asst, Ops, Plns & Trng.

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HEADQUARTERS 40TH BOMBARDMENT GROUP
Office of the Intelligence Officer

APO Number 631
14 September 1944

SUBJECT: Crash landing of B-29 Aircraft #222.

TO : Chief, Intelligence Section, XX Bomber Command, APO 493.

1. Attached hereto statements of Pilot (Captain W. G. RENFRO) and Flight Engineer (F/O J. D. HERBERT) concerning crash landing of B-29 aircraft #222 at this Base on 11 September 1944 at approximately 2100 IST.

2. All crew and passenger personnel aboard the aircraft escaped without injury.

3. On crash landing fire broke out but the prompt arrival and efficient work of the fire fighting teams on the Base were responsible for bringing it quickly under control. As a result considerable salvage will be forthcoming.

/s/ Louis E. Scherck
LOUIS E. SCHERCK,
Major, Air Corps,
Intelligence Officer.

2 Incls -
Incl 1 - Statement, Capt RENFRO
Incl 2 - Statement, F/O HERBERT

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HEADQUARTERS 40TH BOMBARDMENT GROUP
Office of the Intelligence Officer

PILOT'S REPORT 14 September 1944
On Crash of # 222

On September 11, plane 222 left forward area with 2800 gallons of gas. We climbed on course breaking out at 16000' and cruised at that altitude. Power setting was 20-30 and was continually reduced all the way to the rear area.

After approximately six hours of flight we arrived over the home base, entered the traffic pattern and prepared to land. As we turned on the final approach with wheels down and half flaps, the Engineer called me and said we were losing #3 engine. I did not feather the engine because the Engineer told me he was transferring gas from #1 to #3, so I expected the engine to come back in immediately.

Shortly after putting down full flaps #4 and #2 both quit. We were down to about 500 feet by this time and still quite away back from the runway. We pulled up the gear, turned on the landing lights, then called the tower and crew notifying them we were going to crash land. The application of power to #1 engine tended to bring us closer to the field, but it also turned us until we were well to the right of the runway. As we leveled out to land all engines regained their power so we climbed straight ahead hoping to make a downwind landing on our proposed runway. The power lasted for about a minute then all four engines lost power. We made a steep 180° turn back to the field and crashed.

WILLIAM G. REYFRO,
Capt, Air Corps,
Pilot.

FLIGHT ENGINEER'S REPORT
On Crash of #222

On final approach all instruments were normal, fuel boost pumps on, fuel quantity gauges read: #1-300 gal, #2-200 gal, #3-100 gal, and #4-250 gal. (Ship had been leveled and gueges calibrated for pressure at boost pump to quit when guages read as follows: #1-50 gal, #2-30 gal, #3-20 gal, and #4-60 gal. Recent flights had proved them very accurate, although when selector was moved from one tank to another the needle oscillated from 200 gal above to 100 gal below actual reading before settling to one reading.) After wheels and flaps were down #3 engine cut out with the first indication being a drop in fuel pressure to 5 and a few seconds later to zero. I immediately called the Pilot that #3 was going out, hit fuel shut-off switch to "on" position and turned fuel boost pump rheostat to "full on" position. No rise in fuel pressure was noted so I started transferring fuel from #1 tank which had the largest quantity of fuel, Approximately 30 seconds after #3 cut out, #4 also cut out and was followed immediately by #2 --fuel pressure dropping to zero on these two engines, also checked fuel shut-off valves on these engines. Pilot pulled up wheels for crash landing and #2,#3 and #4 engines caught and ran normally for approxi ately one minute and then began cutting out and continued coming off and on until crash landing was made.

JOE D. HIRBERT,
Flight Officer, Air Corps,
Flight Engineer



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# MILITARY INTELLIGENCE DIVISION
## WAR DEPARTMENT GENERAL STAFF
### MILITARY ATTACHÉ REPORT

Country Reported On

Subject (Brief Descriptive Title) WORK OF THE MODEL UNIT-REPORT NO. 3. I. G. No.

FOR RPT NO. 2 SEE K-82468

Source and Degree of Reliability:

K-82467

Summarization of Report
When Required

In Comments on Current Events Enter Item Headings Here

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From M. A. A-2 MODEL UNIT [illegible] BOMBER CMD Report No. Date 26 SEPT. 1944
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Evaluation

SUBJECT: DAMAGE ASSESSMENT REPORT NO. 6.

K-78337

Plajoe refinery, Palenband, Sumatra.

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# MILITARY INTELLIGENCE DIVISION

## WAR DEPARTMENT GENERAL STAFF

### MILITARY ATTACHÉ REPORT

Country Reported On

Subject DAMAGE EVALUATION - SHOWS STEEL WORKS, ANSHAN, MANCHURIA. A.A.F. TARGET 93.3-29. 2nd PHASE (IMMEDIATE POST STRIKE.

Brief Descriptive Title

M.I.D. No.

Source and Degree of Reliability:

K-76850

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# MILITARY INTELLIGENCE DIVISION
## WAR DEPARTMENT GENERAL STAFF
### MILITARY ATTACHÉ REPORT

Country Reported On

Subject THE RADAR NAVI-TRAINER AND RADAR MODELS. I.G. No.
Brief Descriptive Title

Source and Degree of Reliability:

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Summarization of Report
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# MILITARY INTELLIGENCE DIVISION

## WAR DEPARTMENT GENERAL STAFF

### MILITARY ATTACHÉ REPORT

Country Reported On

Subject MEMORANDUM FOR: THE AMBASSADOR. I. G. No.

Source and Degree of Reliability:

K-79042

Summarization of Report

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S E C R E T

C. O.
4445 Bomb Gp
K-91343

STATEMENT MADE BY HERBERT H. SEGUIN, S/Sgt

RIGHT GUNNER ON AIRCRAFT NUMBER 42-6228

11 September 1944.

1. We left A-3 at about 1130 on the 2nd of August 1944. Visibility was good. All the way over the "Hump" we dodged thunder-heads, going off our course to do so, then resuming same. We flew at 19,000' altitude.

2. In the vicinity of Shlhet, India we started climbing to 26,000' to get over a large mass of thunder-heads which our weather chart showed could be topped at that altitude. In the climb the Pilot headed for a saddle between two heads and upon nearing it suddenly banked to the left. While still in the bank we went into a cloud and then it happened. We turned completely over and while on our back we went into a dive making two complete loops. Coming out of the second loop we shot out of the cloud into the clear air in perfect level flight, but rising straight up. While in that position I looked out of right blister at my side of plane and everything seemed normal, wing intact, engines running OK, and tail OK. After holding level position for about one minute the plane started into a dive. The left side gunner broke his sight off and smashed the blister. We both left the plane through this blister while in the dive.

3. As I crawled over to go out the blister, the top gunner was looking for his chute which was on the floor. The Left Gunner jumped at estimated height of fifteen to nineteen thousand feet. I got caught in blister on the way out and left plane at approximately five thousand feet or less. I landed about a quarter of a mile from the plane.

4. Upon landing, I ran to the plane which had landed flat in a natural amphitheatre. It was burning in the nacells and fuselage. I pulled the tail gunner out and found him dead. The radar operator and extra mechanic were in the radar room which burned later. I couldnt get into it at the time. The plane had lost its wing tips and nose section forward of turrets. Also the rudder was gone.

5. A suggestion is made as to securing of floor boards so that equipment underneath cannot get out when plane turns over. We took a terrific beating from that. S/Sgt Martin was found dead hanging from his Parachute in a tree and was brought in by Indians. There were no other survivors other than the Right and Left gunners and of that I am sure. The plane crashed sixty miles southwest of Sylhet, India and the bodies of the crew are buried at Sylhet.

6. Much credit should be given to the outfit of Indian Engineers and the Indian doctor who took care of us.

Herbert H Seguin
HERBERT H. SEGUIN,
S/Sgt, Air Corps,
ASN 11056482
Right Gunner.

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C.O.
445 Bomb. Gp.
K-91343
Date 23 Sep 44

STATEMENT MADE BY FRANCIS A. SHABUNIA, S/Sgt

LEFT GUNNER ON AIRCRAFT NUMBER 42-6228

11 September 1944.

1. We took off from A-3 at 1130 the 2nd of August. We had already crossed the "Hump" when the Navigator called the Pilot and said he could start letting down on course. Our altitude was about 19,000' coming over. The Pilot replied that there was a large thunderhead up ahead and he would have to climb to get over it. He said he believed that he could get through a saddle in the thunderhead at about 22,000'.

2. We started climbing, but when we reached the cloud we did not have enough altitude to clear it. The Pilot banked the ship sharply to the left when the cloud over took us. It caused the ship to roll completely over. It started to roll the second time but only rolled us over on our back. Then we went into two inside loops. There was nothing said over the interphone while this was happening. I broke the left sight off and broke the blister with it. I bailed out when the ship came out of the second loop. After the ship came out of its second loop it went into it's final dive. The ship did not start to break up until it was in this dive. This occured about 1500, approximately 60 miles southwest of Sylhet, Assam, India.

3. While the ship was in these violent maneuvers the floor boards and all loose equipment that was not tied down was flying all over inside the plane. I estimated that I bailed out at about 19,000'. I watched the ship go down as I was falling. As it was going down the rudder, elevators, aileron and wing tips broke off. I figure I pulled my rip cord at about 10 or 11 thousand feet. When the ship hit the ground it burst into flames. Floating down in my parachute I noticed one other chute which later I found out to be the Right Gunner.

4. I am sure that the rest of the crew perished with the plane. Six bodies were recovered and at that time only three were identified. The second day a fourth body was identified. The dog tags of Capt. Reid, Lt. Marszalek, S/Sgt Christ, and S/Sgt Shallcross were recovered. S/Sgt Shallcross body was never identified. The fourth person who was identified was S/Sgt Martin.

5. The nose section landed about a mile from the rest of the ship. Parts of bodies were scattered all around but could not be identified. The ship burned completely except the dorsal fin and horizontal stabilizer.

Francis A. Shabunia

FRANCIS A. SHABUNIA,
S/Sgt, Air Corps,
ASN 31122752
Left Gunner.

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HEADQUARTERS
XX BOMBER COMMAND
APO 493

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XX BOMBER COMMAND

WALK-OUT AND DITCHING REPORTS

B-29 COMBAT CREWS

* * *

through August 1944

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LIST OF REPORTS

| GROUP | AIRCRAFT | PILOT | DATE |
|---|---|---|---|
| 468th | #255 | Sims, J. W. | 1 May 1944 |
| 462nd | #352 | Wagnon, M.K. | 24 May 1944 |
| 462nd | #354 | Smith, E. V. | 31 May 1944 |
| 444th | #361 | Malone, Booth | 5 June 1944 |
| 40th | #304 | Zamry, A. N. | 5 June 1944 |
| 40th | #282 | Sanders, J.N. | 5 June 1944 |
| 468th | #314 | Sloan, L. G. | 8 June 1944 |
| 444th | #246 | Mann, W. T. | 28 June 1944 |
| 462nd | #263 | Waller, D.O. | 8 July 1944 |
| 444th | #302 | Patrick, M.F. | 15 July 1944 |
| 444th | #420 | Furchner, F. T. | 11 August 1944 |
| 40th | #425 | School, W. R. | 19 August 1944 |
| 444th | #320 | Hensinger, C. E. | 20 August 1944 |
| 40th | #308 | Grubaugh, B. L. | 20 August 1944 |
| 462nd | #332 | Sanford, W. L. | 29 August 1944 |

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468th BOMBARDMENT GROUP (VH) AAF
Office of the Intelligence Officer
APO #493

7 May 1944.

SUBJECT: Interrogation of Crew of B-29 A/C 42-6255.
(After Bail Out 50 mi North of Jorhat, 1 May 1944)

TO : Commanding General, 58th Bombardment Wing, APO #493.
(Attn: A. C. of S., A-2)

1. Crew and Passengers:

| | | |
|---|---|---|
| John W. Sims | 1st Lt. | Pilot |
| R. M. Smith | 2nd Lt. | Co-Pilot |
| Robert A. Harden | 1st Lt. | Navigator |
| K. N. Bloes | 2nd Lt. | Bombardier |
| R. M. Roberts | F/O | Flight Engineer |
| R. M. Pottol | 2nd Lt. | Radar Operator |
| John L. Pipkin | Sgt. | Radio Operator |
| R. L. Simmons | Sgt. | Right Gunner |
| R. L. Hollingsworth | Sgt. | Left Gunner |
| E. G. Dunlevie | Sgt. | Top Gunner |
| R. T. Shea | Sgt. | Tail Gunner |
| F. B. Lewis | S/Sgt. | Crew Chief |
| McCarthy | Sgt. | Passenger |
| Mecyra | Cpl. | Passenger |

2. TIME OF TAKE-OFF: 0710 (India Time)
3. TIME A/C FIRST RAN INTO DIFFICULTY: 1145 (India Time)
4. TIME A/C OBSERVED TO CRASH: 1210 (India Time)
5. POSITION OF A/C: 7 mi SE Lakhimpur (27°15'N-94°10'E
6. FLIGHT NARRATIVE:

The plane was at 10,000 feet over Jorhat and a little ahead of its ETA when the climb to 23,000 feet was started. A 360° turn was made in order to get above the weather. Passed 23,000 feet at Sadiya, when they made a 90° turn to start over the first ridge. Started to lose speed 3 minutes after passing Sadiya. At the time they started to lose speed they were climbing at 195, the temperature was approximately 230° during the climb and the cowl flaps were closed. The engines were running at 2400 rpm's and the manifold pressure was 42 inches. The power out-put of the engines dropped and it was found difficult to maintain level flight. The airplane mushed and it was necessary to drop the nose to maintain speed. The pilot turned toward home and called Chabua for position. At this time the plane was losing speed and dropping altitude at the rate of 400 to 500 feet per minute. The speed of the airplane was about 145 mph. The cowl flaps were still closed and temperature was normal or at 220° or 230°. Plane made a 360° turn and received bearing from Chabua.



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Engine #2 began to vibrate and run rough. Oil and nose pressure continued normal, and oil temperature remained normal. Gunner reported a bad leak in #2 engine. The engineer called the oil quantity as it decreased. The pilot estimated the oil loss at 40 gallons per min. and feathered the #2 engine when there was 30 gallons of oil remaining. The pilot felt that it was no longer possible to maintain level flight and Chabua was contacted for an emergency landing. Chabua was closed. The pilot headed for Jorhat. The plane was now at 20,000 feet and unable to hold altitude. The pilot headed for the valley and was still on top of the weather but without ground contact. The clouds were estimated at 14,000 feet in the valley, 23,000 on both sides, and 27,000 feet in front.

Tezpur was aimed for as the pilot knew it to be a class B field for the B-29. Tried to salvo the bomb bay tanks and the cargo which included a spare engine. The bomb bay doors wouldn't operate, but the rear doors were opened fully by the emergency. Was unable to salvo the cargo or bomb bay tanks.

The senior gunner called over the interphone that there was an oil leak in the #1 engine. At this time the airspeed was about 150 mph. The #1 Engine wouldn't feather, but the nose pressure was O.K. Fire then broke out in the #2 engine. The cylinder temperature of the #2 was past 300° when it was feathered. The cylinder temperature of the #1 was also past 300°. The skin on the nacelle of #2 engine was peeling. The pilot ordered the crew to bail out. The altitude was 18,000 feet. The pilot was unable to see the ground. The top of the weather was 14,000 feet and on the sides of the valley about 23,000 feet. The cabin was depressurized and all the crew and passengers bailed out. The pilot stayed with the ship attempting to regain control. He finally jumped at an estimated 4,000 feet.

7. GENERAL INFORMATION:

a. All of the crew and passengers were briefed on emergency procedures for the area.

b. All personnel were equipped with "L & E" material including:

1. Jungle Pack
2. E-3 Aids Box
3. Money Belt
4. Maps
5. Blood Chit

c. No trouble was experienced in clearing the plane through the front wheel hatch.

d. When clearing through the rear hatch all men experienced a pressure which tended to push them backward and into the plane, but no real difficulty was encountered and the men were able to push themselves out.

e. Great difficulty was experienced in getting the parachutes out of the trees.

f. The jungle pack gave no trouble in bailing out and served as an excellent seat pad for tree-top landings.





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g. Heavy vegetation in this area proved to be the greatest obstacle to the personnel. Because of this the machete was found to be the most valuable single item of emergency equipment.

h. The two passengers, S/Sgt Lewis, (the crew chief) who had a sprained knee, and Roberts (the flight engineer) were not present at the interrogation, nor was Lt. Pottol. (2nd Lt. Pottol, R. M. - Radar Operator was unreported at the time of interrogation.) Lt. Pottol's chute was seen to have opened but no further news was brought forth at the interrogation.

8. GENERAL SUGGESTIONS:

(a) A compass be provided which would be available during the parachute descent, thereby enabling a man to orient himself and the direction of the crashed aircraft (or any suitable landmark) before visibility is cut off by a jungle landing.

(b) Whenever possible, the Pilot should keep his A/C on a circular course while the crew bails out. This would increase the chances of all personnel landing close together.

(c) Flares and panels were unsuccessful in attracting planes passing overhead, due to the heavy jungle growth. Inclusion of a small balloon with $CO_2$ capsules and cord in the emergency equipment might overcome this difficulty.

(d) The addition of insect repellant as a supplementary item to the mosquito headnet and gloves already provided in the jungle pack.

(e) A light weight hat for sun protection would be of value.

(f) Crews would be wise to include among their personal equipment a pencil-type fleshlight and leggings. All the men were badly scratched from thorns and undergrowth, especially on the legs.

TIME OF INTERROGATION: 2000, 6 May 1944

/s/ G. P. Putnam,
G. P. PUTNAM,
Major, Air Corps,
Group S-2.

INDIVIDUAL CREW MEMBERS TESTIMONY

LT. SIMS, (Pilot):

The plane was not on C-1 because the weather was rough. The pilot turned the switch on the #2 engine on again in an attempt to get it running, but was unsuccessful. The pilot left his seat in order to shove out the co-pilot who had hesitated at the hatch, but found it unnecessary to do so. He then returned to his seat and the plane was indicating 200 mph. He tried to unfeather the #2 engine which was turning 3600 or 3700 rpm but was unable to do so. Fire then broke out in the #2 engine and the speed of the plane had increased to 300 mph. The plane was in a tight left spiral and the pilot couldn't move the elevator controls. He held full rudder and aileron for about 30 to 40 seconds but the plane wouldn't respond. The plane was by then in the top layer of the overcast, and the pilot stayed with the plane until it had reached 4,000 feet and had broken out of the overcast. The lower layer of overcast was spotty and he was able to see a river.



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The pilot pulled the rip cord of his chute but it didn't open. He estimated he fell 3,000 feet after fully pulling the rip cord and before the chute finally opened about 150 feet above the ground. Two of the panels on opposite sides of the chute split letting the pilot hit the dense vegetation with force, remaining hung above the ground about 30 feet. He estimated he was unconscious three and one-half hours. The plane was a total loss with the possible exception of the tools and the spare engine which it carried. A Col. Hoklin (spelling uncertain) and a Captain Brey of the 52nd Service Group landed in a PT-17 and took him back. A Lt. Smith, the C. O. of a P-40 Group near by heard the crash.

Lt. Sims stated he had no trouble with the parachute emergency kit (jungle pack) when the chute opened. He used the machette in clearing his way in the jungle, used the first aid kit in caring for his minor scratches, and used his compass. He had no water with him, and left his canteen in the ship, but was able to cut a vine and drink the water from it. He had his gun with him and used his emergency rations. He did not know of the head net in the jungle kit, so did not use it although he had need for it. He suggests that insect repellant be added. He used the iodine and the band-aids in his first aid kit. He did not use his L-3 kit or his maps because he saw a B-25 circling overhead, just as he was about to get his maps out.

LT. SMITH, (Co-Pilot):

Smith bailed out at 14,000 feet, saw the plane crash and experienced no great difficulty in landing. He saw a P-40 circling and waved at it. After he was on the ground he met a native about 8 yrs old and showed him the American Flag (blood chit) but received no response. He then went to the plane where the ammunition was still "cooking-off" and directed the natives to keep at a distance. A native took him to a hut where there were some English speaking natives who in turn took him down a trail to the fighter strip at Lillibari.

SGT. DUFILVIL, (Top Gunner):

He bailed out, caught in a tree, but had his jungle kit with him. Before long he met Meeyre and they could hear Harden. They made their way to Harden and all three followed a small trail for about 40 minutes when it ended at a buffalo hole. They then followed the trail for about two hours in the opposite direction when it "petered out". Coming back to a branch they followed that trail until it also ended with a buffalo hole. They were unable to see much of the sky because of the dense vegetation. Using their machette, compass and map they started south. When it began to get dark they made a lean-to and started a fire with the fire starting equipment in the jungle kit, but the rain put out the fire. They were wearing their gloves and headnets because of the mosquitoes. It was not cold but very damp.

When it got light they wrung out their clothes and started south. About noon they came to a clearing 75 by 100 yards and saw aircraft flying around. In the early afternoon they saw a native but he ran away. Later the native returned and took him to a hut where he fed them and gave them a place to stay during the second night. They showed him their flag, but got no response. Native took them to North Lakhimpur.



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SGT. HOLLINGSWORTH, (Left Gunner):

Hollingsworth followed Sgt. Donlevie out of the ship. He delayed pulling his rip cord until he entered the first layer of clouds. His parachute worked immediately and he landed in a tree, skinning his face. It took him three hours to reach calling distance of Sgt. Simmons. Finally he and Simmons reached a clearing of about 60 acres. They used Simmons' parachute for a tent and stood watch at night. They built a fire underneath the parachute in order to keep the rain from putting out the fire. About two P.M. Tuesday afternoon they could see airplanes, but the airplanes didn't spot them, although they had their yellow panels out. They went to the river and were ready to spend the night when they met a native. The native took them to North Lakhimpur as he knew of a party headed by Captain Dean. After dark they went out of North Lakhimpur about two miles where they met Captain Dean who had a jeep and took care of them.

SGT LITKIN, (Radio Operator):

Landed easy. Saw seven natives but made no contact with them as he felt there was too many of them. Late Tuesday morning, the natives took him to the ship. He had taken off his jungle kit and used his compass and machette.

LT. BLOES, (Bombardier):

Hit a level dense jungle. Was able to make about 150 feet in two hours. Heard someone call and followed a creek, but it was no help as it disappeared on both ends. Finally came in an area of thick cane and headed N.W. Put out his panels on top of the cane and lit one flare. An aircraft indicated the direction of Sgt. Lewis and finally picked him up. Lt. Bloes suggested that the passengers should be briefed on the use of the jungle kit as one passenger lost his canteen and threw away his rubber canteen contained in the jungle kit and also his yellow panel.

LT. HARDIN, (Navigator):

The jungle kit split when the chute opened, but nothing was lost from it. He suggested that the machette have a loop on it or some means by which it can be attached to the hand as it is easy for it to slip out of the hand when using it. Also he thought the kit should contain a hat. He tried to use the signalling mirror but without success.

SGT. SILICIO, (Right Gunner):

Landed in tree, and spent an hour in getting the chute out of the tree. He joined Sgt. Hollingsworth's party and had his gun with him.





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SGT. SHEA, (Tail Gunner):

In getting out of the plane he caught on the tail, but got free before opening his chute. He looked down and noticed one side of his chute (chest type) was unhooked, but was able to hook it and pull the rip cord by the time he had fallen half way. He landed in a tree, but was able to cut the chute out of the tree and headed for a river which he reached in six hours. He built a hut along the river and a fire. A native fisherman came along the river and Shea paid him 30 rupees to take him to a village. but when they were still some distance from the village the native refused to take him farther until Shea gave him the rest of the money he had. He gave him the remaining five rupees which he had in his pocket. He did not use his money belt as he didn't want the native to know how much money he had. He met an English speaking native who took him to the fighter strip.

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HEADQUARTERS 462ND BOMBARDMENT GROUP
Office of the Intelligence Officer
APO 493

31 May 1944

SUBJECT: Accident to Plane #42-63352, 24 May 1944 and Experiences of Crew after Bailout.

TO : Commanding General, 58th Bomb Wing, APO 493, P.M., N. Y. C., N. Y.

1. The following report is based upon an interrogation of the crew of plane #42-63352 upon their return to Piardoba after they had bailed out in the vicinity of Netrakona (24°53'N - 90° 43'E).

2. The crew was as follows:

| | | | |
|---|---|---|---|
| Pilot | Major | M. K. Wagnon, | 0-409069 |
| Co-Pilot | 2nd Lt. | Samuel E. Snider, | 0-751046 |
| Navigator | 1st Lt. | Helmer C. Hanson, | 0-662340 |
| Bombardier | 1st Lt. | Loyd Burcham, | 0-669190 |
| Flt Eng | M/Sgt | Alvin J. Lebsack, | 18000967 |
| Radio Opr | T/Sgt | Thomas O. Drew, | 17001613 |
| Right Gun | Sgt. | Robert Snow, | 18047858 |
| Left Gun | Sgt. | Hershell D. Barrett | 19161768 |
| Senior Gun | Sgt. | David F. McNaley, | 37659567 |
| Tail Gun | Sgt. | Buck Blake, | 18010595 |

3. On 24 May 1944, plane #42-63352 took off from advanced base, A-5, at 0052Z. They climed to 25,000' and remained there until reaching Jorhat.

About eight minutes before their Jorhat ETA was up an indication was received on the radio compass that showed they had passed over the station. The navigator thought that they had an increased tail wind and they turned on course for home station.

The pilot started his let down from Jorhat and at about 9,000' altitude there was seen through a break in the overcast a large body of water off to their left. This appeared to be a river opening into a bay. The let down was continued until 5,000' was reached and that altitude was held until they were about 20 minutes out of home station, according to their ETA. At that time the pilot let down through the undercast and broke out at 1200'. After flying for about 15 minutes below the overcast over flat level country, they came to a river with a range of hills to the south of the river. The hills were about the elevation as the altitude at which the aircraft was then flying.



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Not knowing their exact position or whether there might be a higher range ofhills beyond the first range, due to the low overcast, the pilot turned from course of 243° to the left and planned to follow the river untill they reached lower level ground, ran into the bay, or until he had a clearance over the hills and the overcast to cross the range. Following the river he flew a course of 150° to 120° for about ten minutes. The range of hills on the south side of the river was getting higher and extending up into the overcast. A rain was encountered and they climbed to 8,000' and turned back to a heading of 180°. They continued on this course for about 45 minutes flying above the first layer in and out of cumulus clouds. In about 10 minutes an opening was seen and they let down and circled because the tail gunner thought he saw a runway. It turned out to be a strip of water.

The compass began to spin and continued to do so.

They then took a course of 180° in order to reach the Bay of Bengal as they though this would be the easiest way of establishing their position. This heading was followed for about 45 minutes and on instrument conditions and then they saw what they assumed to be a river below Calcutta. They spotted a railroad and followed it 360° for approximately 25 minutes. Number 4 engine had started missing at intervals and the fuel pressure was dropping on the two outboards.

The pilot informed the crew to start making preparations to bail out. The tail Gunner evidently took this as an order to bail out and he left the ship at this time.

They ran into another range of hills to the north - with rain showers scattered around and not enough gas to retrace their steps, the pilot circled a town which later turned out to be Netrakona and ordered the crew to bail out.

They were unable to make any radio contacts or secure any radio aids in time to save the ship. The radio operator was trying to contact ground stations from the time they were 150 miles out of home station. After failure to make contact with home station the pilot asked the operator to try to contact one of the other three fields in the Wing and request the range to be turned on and to get a bearing. The radio operator was unable to contacttheir ground stations. The only radio aid the pilot could pick up on the Command set was the homing signal from Kharagpur. They were unable to pick up any signal on the radio compass. Just about 5 minutes before abandoning ship the radio operator was able to contact Calcutta. He asked for a bearing and stated they might have to bail out at any minute. Calcutta repeated the message and asked if it was correct. The radio operator told him the message was correct, and asked for a bearing again. At that time he was ordered to bail out so he called Calcutta again and stated that they were abandoning ship.





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On the return trip there was aboard the ship 3780 gallons of gas which the flight engineer figured was 1100 gallons more than was needed.

All members of the crew, except the tail gunner, S/Sgt Buck Blake, were present at the interrogation. Sgt Blake is at present at the 112th Station Hospital, APO 465 with a broken leg suffered when he hit the ground.

The members of the crew had been briefed several times on Escape and Evasion procedure and no particularly unusual occurrences were reported.

The crew was supplied with money belts containing maps of North and South Burma, Central China & French Indo-China and Southeast China also Northeast China, Blood chit, and currency of India and China. They also had their jungle kits. Most of them found the Indian money in the money belt very useful.

4. A brief statement of the experience of each crew member follows with exception of Blake from the time they left the ship:

Major Wagnon - Bailed out at 1700' through the nose wheel access door. He delayed pulling the rip-cord long enough to slow down. He pulled once but the chute did not open - He pulled again and it opened at about 800'. Upon hitting the ground the buckles on the back of the chute struck him on the back of his head, and knocked him out for a moment. He had no trouble with his jungle kit, canteen or pistol. Before bailing out he had put a flashlight in his coveralls. He landed about 8 miles north of Netrakona. It was about 1445. Numerous natives gathered around. They were the same sort of natives one finds around Piardoba. One of them spoke English. The natives took him to a village where he met Lt. Burcham. The native took them to a house and insisted that they lie down. They brought food and milk to them but they declined as graciously as possible. The milk was hot and dirty. They stayed at this house for about an hour and then started for that town. A guide took them there. There they met Sgt. Drew, Lt. Hansen and Sgt. Lobsack. They were taken to the Police Station. He sent a telegram to Piardoba and waited for a reply. The next morning he sent another one.

They left about 1600 on the train. At Mymensing (24°57'N-90°36'E) they were taken to British Quarters. Major Wagnon called the S-2 at Dacca and asked him to relay a message to Piardoba. They remained overnight and then were flown to Piardoba on 27 May 1944.

Major Wagnon said that by flying his plane in a circle as he had been briefed to do in the event of a bailout his crew was enabled to get together quickly upon reaching the ground.



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All of the natives wanted tips. They were all curious about what the crewmen were doing there. They asked numerous times, "What is your purpose here?" One asked "Is it true India will be paying America 100 years after the war?" Major Wagnon answered "Of course not!"

On the route back he was handed the note attached hereto and marked on the back of Exhibit A.

He thinks the plane is somewhere in the vicinity of Baghmara, (25°11'N-90°38'E).

Lt. Loyd Burcham - Lt. Burcham was the third man out of the nose of the plane. He bailed out at about 2000! He hit in a soft place about 5 miles NE of Netrakona. He met Major Wagnon a few minutes later.

Sgt. Thomas C. Drew - Sgt Drew was the first one out of the nose. He bailed out at about 2500'. He had no trouble bailing out and his chute opened immediately. He fell about 5 miles north of Netrakona, about a mile from Lt.Hansen. He fell in the middle of a stream, and some natives around helped him spill his chute. He then met Lt. Hansen and later they met Major Wagnon.

Lt. Helmer C. Hansen.- Lt. Hansen bailed out at about 2200' through the nose wheel, access door. He had no trouble bailing out. He fell free about 5 or 600 feet and then pulled the rip cord. The chute opened all right. He landed in an open field and sprained his right leg. He landed about 5 miles north of Netrakona. The natives gathered around and helped him carry his chute to a small settlement. There he met Sgt Drew. Later they met Sgt Lobsack and Major Wagnon and Lt. Burcham.

M/Sgt A. J. Lobsack - Sgt Lobsack was the 4th man out of the nose. He bailed out at about 2000'. He had no trouble getting his chute to open. He landed about 10 miles north of Netrakona. Natives were all around him but would not come up to him. He tried to make them understand that he wanted to find the nearest train but they didn't understand. Finally he made motions indicating a train and made a noise like one. Then they understood and started off across the country and then he met Lt. Hansen and Sgt Drew and later joined Major Wagnon and Lt. Samuel E. Snider. Lt. Snider bailed out at 1700'. He fell freeabout ½ of the way. Then he pulled the rip cord but it did not open. He pulled harder and it opened all right. Helanded in a dry rice paddy. Two natives caught hold of his chute and spilled it. He was about 6 miles west of Netrakona. He asked for the "Headman" and was referred to the "President" of the village. The President took him to his home, gave him mangoes, tea, water (it was brown in a dirty glass. He only took a sip of it.) coconuts, bread and fruit. The President didn't know how to tell him where he was. So he finally put an "X" on a piece of paper, then a compass rose and then "Calcuua under the "X" and the President





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marked where he was. The President wanted to see all of his equipment. Two boys came up who could speak English and he arranged for a horse and a bearer and went to Netrakona. There he sent a telegram to the CO, Piardoba. Also he met Sgt's Snow, Barrett, and McNeeley. They rode to Mymensing by train, then to Okhaura Junction and then to a British Airfield at Agartala (23°45'N-91°15'E) At the latter place the British fed the men and put them on a C-53 for Dum Dum and then the day after that they came on to Kharagpur.

Lt. Snider suggests that a map of India be included with E and E equipment.

Sgt. Hershell D. Barrett Jr. - Sgt Barrett went out of the back door. The straps on his chute hooked on the door. He thinks the door should be bigger. He had a hard time getting out because of the smallness of the door and the wind resistance. He hit on about 3½" of water, and many natives were around. He was about 2 miles north of Netrakona in Union #2. The natives took him to the President. On the way he met Sgt. McNeeley. They walked into Netrakona together. About an hour later Sgt. Snow showed up. The police gave them dinner in a private office.

Sgt David F. McNeeley - He went out back door at about 2000'. The chute caught on the door and Snow pushed him out. He hit about 2 miles north of Netrakona. The natives were around but seemed scared of him. On reaching the ground his head hit a rock in some shallow water and rendered him unconscious for a few moments. He was lying face down in the water. One of the natives spilled his chute for him and raised his head out of the water. This native had a GI truck drivers license and could talk a little English. He asked for the magistrate and was taken to the President of the nearest settlement. He gave his parachute to the President and had to sign a statement to this effect. Met Sgt Barret and Sgt Snow.

Sgt. Robert Snow - Went out rear door at 2000' - had difficulty getting out due to smallness of exit and wind resistence. He had to push himself out and fell free about 1000' or 1200' before pulling the rip cord. He landed about 4 miles SW of Netrakona. Many natives were around, one of whom could speak English, and asked Sgt Snow what his purpose was in coming and invited him to his home. They tried to get him to eat something but Snow wouldn't take anything but mangoes. Snow gave him a package of cigarettes and some gum which pleased the President. The latter took him to the Police Stattion where he met Barrett, McNeeley and Snider.

Interrogating Officer
/s/ Walter E. Boyd,
WALTER E. BOYD,
1st Lt., A. C.,
Asst Intell O.

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HEADQUARTERS 462ND BOMBARDMENT GROUP
Office of the Intelligence Officer
APO 493

WEB/sbc

6 June 1944

SUBJECT: Bail-Out of 4 Members of Crew.

TO : Commanding Officer, 58th Bombardment Wing, APO 493.

1. Herewith is submitted a report of an occurrence on 31 May 1944, when 4 crew members of a B-29 aircraft, #42-6354, bailed out in China.

2. The crew was composed of the following:

| | |
|---|---|
| Pilot | SMITH, EGBERT V., Captain, 0726292. |
| Co-pilot | HERRINGTON, ALVIN E., 2nd Lt., 0751130. |
| Nav-Bomb | DE MARDI, ROCCO E., 2nd Lt., 0681952. |
| Bomb-Nav | PRICE, THOMAS L., 1st Lt., 0404349. |
| Flt Eng | Botzer, John B., M/Sgt., 6995349. |
| Radio Op | Paszkowski, Chester J., S/Sgt., 36320061. |
| CFC | Williams, Thomas M., Jr., S/Sgt., 14029244. |
| R Gunner | Peeples, Clarence A., Cpl, 38528061. |
| L Gunner | Graves, Carl.F., Sgt., 39029174. |
| T Gunner | Thomas, John.H., Sgt., 36176142. |
| Radar O | AULT, GORDON (NMI), 2nd Lt., 0863652. |

3. From an interrogation of the crew the day after they reached this field the following facts appear:

After leaving A-5 for this field an oil leak was noticed on Engine #4. This was about 0220Z. It increased to a steady flow of oil and blue smoke was coming from the engine so the props were feathered. Due to the fact they were not over the hump it was decided to return to A-5. At this time they were at 23,000 feet.

At about 0240Z turbo was lost on #1 engine and it dropped to about 18 or 20 inches of manifold pressure.

They were losing altitude fast and had to take to the valleys. Consequently they got off course. They flew for about 40 minutes following the valleys and streams until they came out on the plains. They were about 1000 feet.

#1 engine RPM was not responding properly and was not putting out enough power to maintain altitude.

#4 engine was started again but it appeared to be on fire so it was refeathered.



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Air speed at this time was about 140 mph. The plane shuddered and the pilot ordered the crew to bail out.

The crew was ready to bail as they had received instructions prior to that time to be prepared for such a contingency and four of them bailed.

Just a moment after the order to bail was given the pilot noticed a field directly in front of them, the order to bail was countermanded, and the ship landed. The field was A-7

4. An account of the experiences of crew members who bailed-out follows:

Cpl. Clarence A. Peeples - Bailed out of the back door at about 800 feet. His canteen caught on the door.

The natives came up as he landed. He made motions that there were 11 men in the crew and, as best he could, asked them to help locate them. One of the natives shouted out something and away went some of the natives in all directions. They carried his chute and jungle kit and took him to a school house. There he met Sgt. Williams.

A jeep came and took them to A-7.

S/Sgt T.M. Williams - He was treated very nicely by the natives. A great number were present when he landed. He got his naps out of his money belts but none of them was any good for that part of China. His "pointee-talkie" came in very handy. A jeep came and took Cpl. Peeples and him back to A-7.

Sgt. Graves - Had difficulty in getting out of the Rear Door. He had to be pushed. He pulled his Rip-Cord about 2 seconds after leaving the plane. The chute did not open so he grasped the rip cord wire with his hands and pulled it all out. Then the chute opened. The shroud lines were tangled and the chute never did open fully.

He hit in a rice-paddy. There were a number of natives around him but they continued to work as though they hadn't seen him. This caused him to think he was in enemy territory, so he started to dragging his chute towards some brush. Then the people came over. They were laughing at him because he was covered with mud. He tried his "pointee-talkee" but got better results with making signs with his hands.

They took him to a mill, carrying his chute and washed him. He passed out cigarettes to all of them. They waited upon him in every way possible and were very friendly. They laughed almost continuously.

He walked about a mile where he was picked up by Lt. Price in a jeep.

Sgt. John H. Thomas - Jumped at about 7 or 800 feet. Upon landing







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the natives in the vicinity continued to work. Thinking he was in enemy territory he dashed for the woods with his chute. He looked around and saw "about 500" natives coming toward him so he pulled out his blood chit and showed it to them. Then he talked with them using his pointee-talkee. He passed around cigarettes. They were very kind to him and cared for them in every way possible.

He was taken to a road and picked up by a jeep.

He thinks that both the rear door and Tail Gunners hatch are too small.

Note: 1. None of the above men could give an accurate location of where they hit the ground but state that it was only a few miles south of A-7.

2. The crews at this field have been told during briefing on Evasion & Escape that sometimes in occupied China the natives will ignore them when they hit the ground but if they hide, the natives will come after dark and seek them out and help them. This explains the action of Graves and Thomas in heading for cover when the natives seemed not to notice them.

WALTER E. BOYD
1st Lt. Air Corps,
Ass't Group S-2
Interrogating Officer

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Dated: 11 September 1944.







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SUBJECT: Accident to Plane 42-361, 6 June 1944.

TO : Intelligence Officer, 444th Bombardment Group, APO 493.

1. The following report is based upon an interrogation of the crew of plane #42-361 upon their return to Chanra after they had bailed out in the vicinity 7 miles south of YU-CHI, China. The appendix attached to this report is a supplement to the formal report made by individual crew members in a meeting with Colonel Alva Harvey, Commanding Officer, 444th Bomb Group at 0900 12 June 1944.

2. The crew was as follows:

| | | |
|---|---|---|
| Malone, B. G. | Major | Pilot |
| Bettis, N. T. | 1st Lt. | Co-Pilot |
| Means, D. T. | Captain | Navigator |
| Jones, R. L. | 2nd Lt. | Bombardier |
| Shoals, R. M. | 2nd Lt. | Flt Engineer |
| Bolt, B. B. | Sgt | Radio Operator |
| Kittredge, W. F. | S/Sgt. | Radar Operator |
| Barnes, L. D. | Sgt | Senior Gunner |
| Cron, A. D. | S/Sgt | Right Gunner |
| Bodie, I. L. | S/Sgt | Left Gunner |
| Lane, A. H. | S/Sgt | Tail Gunner |
| Christner, S. L. | T/Sgt | Crew Chief |

3. On 6 June 1944, plane #42-361 took off from Kharagpur at 0600. They climbed to 2,000 feet and joined formation of four other planes from 678th squadron and proceeded to target as briefed.

4. Ten (10) minutes after leaving target #1 engine ran out of gas, probably because engine had to pull rated power for an hour longer than expected in order to get to altitude. Major Malone realized that the gauges were reading wrong and did not have enough gas to get back to the home base. It was ascertained that there were 1500 gallons in wing tanks and 1200 gallons in the bomb bay tanks. Thereafter the plane set a course for Kunming since it was the nearest base and at a point 7 miles south of YU-CHI or about 60 miles south of Kunming. All engines started to sputter due to lack of gas and the ship was abandoned. All but the right gunner bailed out safely. The latter remained in the ship and was killed in the crash.

The crew landed in a valley and were immediately taken to local Chinese Headquarters and thereafter the crew was taken to YU-CHI and stayed overnight at the China Inland Mission - about noon the next day the crew was picked up by Captain Mullen of the ACAS who took them to Kunming. Captain Means and Sgt Christner sustained fractured ankles and at the time of this report are still in Kunming.



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The crew returned yesterday afternoon Via ATC after spending two nights in DUM DUM airport at Calcutta.

/s/ Edmund B. Sullivan,
EDMUND B. SULLIVAN,
Captain, Air Corps,
Intelligence Officer.

APO #493, c/o Postmaster,
New York, New York,
11 June 1944.

STATEMENT

SUBJECT: Crash of Airplane B-29, 42-6361.

TO : Whom It May Concern.

1. We were flying B-29 42-6361 on 5 June 1944. The ship flew normally for the first part of the trip but after climbing above 11000 or 12000 feet a compression loss was noticed on #3 engine, which cut our rate of climb and made it necessary for us to pull rated power for about one hour longer than anticipated, to reach our altitude and caused us to lose our formation. However just before entering the target our gas gauges showed plenty of fuel for the return trip. Just after leaving the target, #1 engine went out and it was found to be due to lack of fuel. Going then on the assumption that all engines were in about the same shape I decided that all the fuel we had left was in our two remaining bomb bay tanks which I counted on for four hours flying time, so I instructed the navigator to set a course for Kunming or any other field he could find closer. Kunming proved to be the closest we could find. The ship at this time did not attain the airspeed we expected with our light weight and we were never able to go below 2100 RPM to maintain 190 MPH losing altitude gradually. All loose equipment was jettisoned as soon as transfer of fuel had been completed. It became apparent that we would not last to Kunming so all classified equipment was ordered destroyed, as we were not sure how far enemy lines extended. We had no radio facilities for the area and the radio Operator had previously been trying to get contact. The only contact made was with Chittigong. By the time we had reached 7500 feet indicated with the hills indicating 5800 feet all personnel were ordered to the rear to stand by the rear bomb bay except the pilot, co-pilot, radio operator and engineer. Just as the engines were beginning to sputter we saw a valley ahead of us and every one got into the bomb bay with one man standing by on interphone to get the order to jump. The rear bomb-bay was opened by the emergency pull and the nose wheel was extended on the emergency system.



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The order to jump was given as we entered the valley at 7000 feet indicated at about 1530 hours. After the front was cleared I called on interphone to see if all were out and received no response and assumed that they were, but as I jumped I saw that they were still jumping out the back. S/Sgt A. O. Oren did not leave the ship and was killed when the ship crashed on the far side of the valley. It was later determined that he was the one on interphone.

2. We were picked up by Chinese soldiers, taken to their Headquarters and later taken to the China Inland Mission not far away in the town of YU-CHI. There we spent the night and were picked up the next day by Captain Mullen of AGAS and taken to Kunming. Before we left we went back to the scene of the crash and destroyed all the loose paper around and recovered S/Sgt Oren's body which was found in the bomb-bay badly burned as the ship had been almost completely consumed by fire, only the tail section being intact.

3. From Kunming we were returned to our base by ATC.

4. I certify that is a true and complete statement.

/s/ Booth G. Malone,
BOOTH G. MALONE,
Major, Air Corps,
Air Plane Commander.

HEADQUARTERS, AGAS-CHINA
APO 627 USAF CBI

7 June 1944

SUBJECT: A talk with the leader of the Chinese guards about the crash of Plane 42-6361.

TO : Major A. R. Wichtrich, Commanding, AGAS-China.

1. The following information was obtained in a talk between James W. Chen of AGAS-China and the leader of the Chinese guards assigned to guard duty around the wreckage:

A. Plane seen by Chinese prior to the crash:

At about 3:20 p.m. on 4 June the plane was seen by the Chinese villagers and soldiers in the vicinity of YUKI (YU CHI; 102° 33'E-24° 17'N), Yunnan province, China. It flew very low at first and came right down to the village. But, in order to avoid crashing the village, it was believed, the plane gained altitude and crash-landed on the suburb of the village beside the farmland. It was later told by the Chinese General that the Chinese people felt grateful for this American act of sparing the village.







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B. After the crash: The plane crash-landed at about 3:30 p.m. at Tow Yuen Kai of Ho Fu Village in Yuki Hsien. At the crash men with parachutes were seen landing on various points around the village. The Chinese soldiers of the 3rd Company of the 2nd Regiment under the Temporary 32nd Division were given orders to search and rescue the downed fliers. Villagers, for the sake of curiosity, ran to the plane to see the grand exhibition. Unfortunately, a few minutes later, the gas tank exploded and this killed 3 villagers and wounded more than ten, including a child.

Meantime, 11 crew members were found by the Chinese soldiers and were invited to the Chinese Company Headquarters about 30 minutes hike from the wreckage. Telephone message was immediately dispatched to the Divisional Headquarters in Yuki town, upon receipt of which the Commander, General Pang Shuo Dwan, immediately sent a truck for these men. After that the men were received and housed by the missionaries of the China Inland Mission in that town. However, the dead and wounded villagers were taken by their families back to their homes in that village. The plane kept on burning until 8 o'clock on June 6th morning.

/s/James W. Chen,
JAMES W. CHEN,
Secretary, AGAS-China.

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HEADQUARTERS
40TH BOMBARDMENT GROUP
Office of the Intelligence Officer

APO #631.
11 June 44.

Narrative of Ditching by Crew of A/C #304

B-29 aircraft #304 of the 395th Bomb Sq took off at 2359Z, 4 June 44, in accordance with F. O. #2, 58th Bomb Wing, dated 2 June 1944. On returning alone from mission this ship was forced to ditch at approximately 0940Z at 20°50'N - 88°00'E. Mechanical failure of fuel transfer system necessitated ditching when gas supply in wing tanks was exhausted.

At the time of ditching the personnel of the airplane consisted of 12 men (11 combat crew members and 1 passenger). Ten men were rescued and two combat crew men were lost.

| Postition | Name and Rank | Status |
|---|---|---|
| Pilot | Maj A. N. Zamry | Missing |
| Nav Bomb | 1st Lt. J. W. Evans | Slightly injured |
| Radar Opr | 2nd Lt. J. C. Beal | Seriously injured |
| Co-Pilot | 2nd Lt. A. L. Briggs | Slightly injured |
| Bomb Nav | 1st Lt. B. F. Woptika | Slightly injured |
| Engineer | 2nd Lt. J. E. Phalon | Slightly injured |
| Tail Gunner | T/Sgt. W. F. O'Connell | Slightly injured |
| Senior Gunner | Sgt. M. E. Belcher | Slightly injured |
| Right Gunner | Sgt. G. F. Bleyl | Slightly injured |
| Left Gunner | Sgt. W. W. Waseman | Seriously injured |
| Radio Operator | Cpl. J. W. Harvey | Missing |
| Passenger | Capt. W. E. DrislaneIII | Slightly injured |

The survivors were returned to the 112th Station Hospital, APO #465, New York City. Capt Drislane and Lt. Seal were not interrogated because of their condition. The following are the individual statements of the other survivors:

Co-Pilot - 2nd Lt A. L. Briggs

We had trouble with our transfer system prior to the mission, but thought that this problem had now been remedied. We were about two hours away (approx. 0715Z) from the target when we had our first indication of trouble, which was smoke coming from the engineer's panel. The Engineer attempted to fix the system and succeeded for a short time, but then the system burned completely out.



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At the first sign of trouble the fuel gauges were checked and it was found that #1 engine was the lowest of the four and would be the first to go. Power was reduced on all engines and we let down from 15,000' to 10,000'so we could depressurize and get back in the ship and work. Enough air speed was kept up so the ship wouldn't mush along and, therefore use more gas in the long run. The IAS was at all times between 165 MPH and 185 MPH.

One hour later (0815Z) we realized that we probably wouldn't be able to make land so the pilot gave the crew instructions to make preparations for ditching. All loose equipment was put in the forward bomb bay on the catwalk; however, the pilot gave instructions to move it off on to the bomb bay doors to prevent it from sliding forward through the hatch on impact. All personnel were instructed to fill their canteens and to take what equipment they would need for survival at sea. A five gallon water jug was filled to take with us.

In forty five minutes (0900Z) #1 engine started cutting out so it was feathered. Power was increased on the other three and we started losing altitude at approximately 200' a minute to maintain our air speed. Everything was normal for five minutes then #3 began cutting out. We knew it still had gas so we nursed it along. It would have a surge of power and then drag. This went on for thirty minutes. Then it had to be feathered. An attempt was made to unfeather the engine, but it was unsuccessful.

We realized then that only with the best of luck would we make land. The ship was indicating approximately 150 MPH and pulling forty inches of manifold pressure and 2300 RPM. The pilot then ordered the bomb bay tanks to be emptied through the butterfly cocks and allowed to leak through the bomb bay doors. He also ordered the ammunition to be expended to make the ship as light as possible. He later stopped expending the ammunition when he realized the danger from the gas fumes in the plane. The crew members at their ditching stations complained of the gas fumes so I ordered the left gunner to open the rear escape hatch to give them more air. The ship flew normally for 10 minutes and then #4 cut out. The pilot immediately shut off all power and started down. The sea was calm and there was only a few white caps. The crew was alerted and the alarm bell turned on. The pilot called for full flaps at 130 IAS. The tail touched just lightly once at 105 IAS and a few seconds later a little harder. The pilot then closed his window. A moment later we hit the water for the third and final time. There was a terrible grinding and crumbling noise as the nose went under water. I was thrown forward against the armor plate glass; however, I had my seat cushion in front of my head and I attribute this to saving my life.

The nose filled with water immediately so I think the nose broke up. I reached up and pulled myself through the window and took four to six strokes to reach the surface. I saw that







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the life rafts had not been pulled so I crawled up on the wing and released the doors for the right raft which did not inflate so I had to pull the $CO_2$ bottle on this one. I gave this raft to the Engineer and then went to release the left raft. I also had to pull the $CO_2$ bottle on this one since it did not automatically inflat. I had a hard time getting the dinghy away from the airplane. I tried to untie the paddles, but the rope was knotted so I chewed it in two. With the aid of the paddles, I was able to clear the plane. The tail section had broken off just behind the gunners' compartment and was being held on to the major portion of the ship by a few control cables. The other crew members informed me that there was an explosion in the rear bomb bay, but I was not aware of it. I picked up three men in my dinghy and the Engineer also picked up three men. We got the two dinghys together and sighted two other men about 1000 yds away which we identified as the Radar Operator and Left Gunner. Both boats tried to reach them until dark and then gave up the job as hopeless, against the rising sea and tide. I had seen another B-29 make a 180° turn over us off to the right as I was climbing on to the wing so we expected to be picked up at least by noon the next day.

We settled down for the night and took stock of what equipment we had which was as follows: 5 cans of water, 1 canteen of water, 1 jungle kit, 1 life vest (with medical supplies, food, and miscellaneous survival equipment), 3 E-3 Kits, 2 cans of hard sugar candy, 1 "Gibson Girl". We figured we could last a long time if we could just get more water.

I took off the cover of the Gibson Girl and tied a rope to it and shoved it down in the water with the oar and found that it made a very good sea anchor. During the night we had to weather two short squalls--one at about 1330Z and the other at 2000Z. We held the dinghys abeam with the oars laced through the rubber rings on each raft. We were afraid that the rough sea would upset our boats if we tied them in trail. All crew members, with the exception of the Engineer and myself, appeared to be visibly shaken from the explosion in the rear of the ship. Everyone bedded down as best he could with the exception of myself and I sat up and prayed that everything would turn out O.K.

We had seen a buoy just before nightfall and decided that in the morning we would try to tie on to it, provided we were in the same vicinity. Approximately at daybreak )6 June, 44) we sighted a buoy, but in view of the two squalls we had been through I do not think that it was the same buoy. We rowed up to it. We then tried to use our "Gibson Girl Radio". It was too calm to fly the kite and the balloons had been lost so we separated the rafts and extended the antenna between them. We were getting current, but got no indication we were "putting out". The SOS signal was cranked out 15 minutes before and 15 minutes after the hour GCT and then we cranked steady for about an hour.





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We were beginning to need water because the hot sun and rowing we were doing made us very thirsty. We rationed our water from the beginning, but the supply was now getting very low. At 0400Z that morning I sighted something that was either land or a boat in the horizon so we eagerly started rowing and sailing toward it. We tried to reach land for about 5 hours and then gave up very tired and dejected because the tide was carrying us out faster than we could row and sail. We knew this to be true because the Navigator had started fishing and the line would trail in the direction we were trying to move.

At this time we sighted two objects to our right bobbing in the water and decided to go investigate. As we got within 200 yards we saw it was the two crew members (Radar Operator and Left Gunner) we had failed to reach the day before. The Left Gunner was holding the Radar Operator's head out of water by pushing him up on an oxygen bottle they had picked up floating in the water. The Left Gunner said he was O. K. and to get the Lieutenant out of the water first because he was injured seriously. We pulled the Radar Operator into the boat and started to attend to his wounds with the drugs and bandages from the Engineers life vest. He had a compound fracture of the left leg. Two leg bones were sticking through the calf of his leg and there was a hole about an inch square in the top of his knee straight down to the bone. The right leg also had a hole in it on the inside of his ankle in which the ankle bone was visible. His right arm was obviously broken and he complained of his left hip which we later found out from the doctor was broken. He was delirious from pain and was obviously out of his head. The Engineer poured an excess of sulfanilamide powder into all his wounds and used the compresses and bandages that were available from the vest. A splint out of one set of oars was made for his leg to prevent the bones from grinding together and causing him terrible pain. The Engineer then gave him a syrette of morphine and this seemed to make him rest easier for a few hours.

To our surprise we found that the Left Gunner had three large cuts in the back of his neck and lacerations over the top of his head. One of the deep cuts in his neck only missed the large artery in the right side of his neck about 1/8 of an inch. This artery was plainly visible through the gash. The left upper arm was also gashed exposing the bone. The Engineer also poured an excess of sulfanilamide powder in his wounds and bandaged them with his first aid equipment.

The Left Gunner undoubtedly did one of the most wonderful jobs of self sacrifice beyond the call of duty that I know of, in holding the Radar Operator afloat for approximately 24 hours. This opinion is shared with me by all crew members.







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We decided to separate the dinghys about 1300Z and each group try to reach shore individually. I took the Engineer, Radar Operator. Left Gunner and Tail Gunner with me. Both dinghys became separated about 3 miles. At dark I realized we weren't making any headway so we decided to make ourselves as comfortable as possible. We had given the rest of our water to the two wounded men and now everyone was suffering miserably from thirst. We had been eating the candy charms from the Engineers vest and those in the life raft and they helped relieve our thirst a great deal.

Approximately at midnight I felt a NW wind coming up so I roused the men and we put up our sail and were going to try to make land. At 2100Z we were getting very close because we could hear the waves beating on the mud banks. As we neared them we saw they were six to eight feet high. The Engineer and I prayed together that we would wash over the banks on a crest of a high wave so our boat would not be overturned and the Radar Operator suffer more pain. We floated up high and dry on the bank. We then started unloading the wounded men and supplies. We dropped the Radar Operator and he screamed in pain which I assure you hurt us as much as it did him. He was delirious again since the morphine had worn off and we had no more. We built a fire and made ourselves as comfortable as possible for the night. We covered the two wounded men with the sail. We all slept around the fire because it was chilly.

That morning about 2300Z the Engineer and Tail Gunner went to look for an Indian they thought they saw. The Left Gunner set up the Gibson Girl and cranked out an SOS. This time there was an indication that he was putting out. He cranked the radio 15 minutes before and 15 minutes after the hour and then cranked steadyfor about an hour. The Engineer and the Tail Gunner returned at approximately 0300Z (7 June 44) with no results. Everyone was suffering terribly from thirst. Myself and the Tail Gunner then took off on a search for 3 hours and still found no water or natives. We would taste the water in small inland pools, but it was all salty. It was about noon now and very hot. The Radar Operator had rolled over on his face in the sand and was very delirious. He kept asking for water so we decided we would have to get some. I then tried distilling salt water. We took the rubber hose off a Mae West and attached it to the oxygen bottle we had filled with salt water. We then boiled the water and caught the steam in a plastic water bottle on the other end of the rubber hose. We poured cool sea water on the water bag to help condense the steam. It was very hot work, but we managed to get about 1/2 a pint of water this way. We gave the water to the Radar Operator. It was brackish, but not too bad. We made a tent for the 2 wounded men out of the sail, for the purpose of keeping them out of the sun. We used the maps out of our money belts and life vest to wet rags for the heads of the two wounded men. We kept them as moist as possible as a means of keeping them cool. The maps also come in handy for this operation. The rest of us would lay in the cool water on the mud flats and



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this helped us a great deal.

The Engineer and I told the Tail Gunner that we were going to look for help and wouldn't return until we found aid. The Tail Gunner was to look after the two wounded men.

We walked up the beach about 5 miles and didn't find a thing. We decided to lay in the water awhile and rest. While we were resting we sighted a native and both of us started toward him smiling and waving to him. He smiled back and we gave him 3 silver rupees. He could not speak English but through motions and the word "Pani" he knew what we wanted. We followed him for approximately 3 miles to a little pool. He brushed the scum off the water and rinsed his mouth and told us to do the same which we did. He then took us on to a village where we were given drinking water and food. We used halozone tablets in the water and drank our fill. A native who was obviously the Chief in the area came to us and spoke broken English. We learned from him that we were on an island near the mouth of the Hoogley River. We told him there were 3 others (2 seriously wounded) and told him where they were. He got his boat and we went after them. We made a stretcher for the Radar Operator by cutting the oval ends out of one life raft and sticking poles through it. We then put two cross bars between the carrying poles to hold the stretcher taut. Thenatives then carried him about 7 miles to a native hospital where a native doctor dressed his wounds again. The doctor took the Engineers life vest and cut up the vest taking out all the medicines and equipment which we were now glad to give to him. The Engineer, Tail Gunner, and myself went back to the native village where the Indians were preparing a fish dinner for us, with fried rice. It was now almost 1600Z when a native came in saying he had sighted 5 other men not far away. We got in the boat and picked up the other men of our crew. We carried water to them in the plastic water bottle and native jugs and used halozone tablets in the water. We all returned to the village and went to sleep. The next day we were picked up by a PBY which we signalled with a flash mirror. The Indians had sent for help by sending a runner 18 miles to Diamond Harbor on the Hoogley River where a radio message was sent to ASR in Calcutta.

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Navigator- 1st Lt. J. W. Evans

The Pilot instructed the Radio Operator to turn on the IFF to the very wide or #3 position. I furnished him with a position report for 0901Z of 20° 07'N - 89° 00'E. Before I was ordered to my ditching station I furnished him with a position report for 0931Z but I do not know whether he ever sent it. Everyone was unbelieveably calm and crew discipline was excellent.



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I braced myself against the armor plate wall in the front of the radar compartment. I put on a summer flying helmet sideways so the earphone compartments guarded the front and back of my head. I then wrapped a B-10 flying jacket around my head and held my head back against the wall so there would be no snap of my neck on impact. I had a B-10 flying jacket on with 2 E-3 Sustenance kits in the side pockets as well as a full canteen of water and a Carlisle First Aid Packet. The gas fumes in the rear of the ship were suffocating us so the Left Gunner opened the rear escape hatch.

I remember the ship touched the water twice lightly and then everything is blank. I think we exploded because I found myself in the water near the airplane. There was yellow flame and smoke in the bomb bays for approximately 30 seconds. I was stunned and very weak. I inflated my Mae West and decided to let them pick me up in the life raft, but I began to drift away so I swam to the dinghy the Engineer was paddling. My field jacket with E-3 kits had been blown off and only the arms were left. We tried to pick up the Radar Operator and Left Gunner, but were unable to do so before dark in the rising sea and tide.

I had a miserable night in the dinghy because my left arm was paining me and I thought it was broken. It rained about 1400Z but we did not bother about catching water because we believed we had been sighted and would be picked up the next day. I started to eat a D-ration bar and some malted milk dextrose tablets that night that the Engineer gave me, but stopped because they made me thirsty.

The next day (6 June 44) was uneventful except for picking up the Radar Operator and Left Gunner which the Co-Pilot had already told you about. I tried fishing for about an hour, but had no luck. When we sighted land and started paddling toward it we were actually going backwards faster than we could paddle forward because my fishing line was dragging in front of the boat.

When we separated the two dinghys I had the Bombardier, Senior Gunner, Right Gunner and Passenger with me. We were about a mile ahead and a mile to the right of the other dinghy when we decided to give up and bed down for the night. I noticed a strong northernly wind coming up so we put up our sail about 0800Z and sailed into shore about 2100Z. We tried to start a fire with our matches from the E-3 Kits but they had gotten damp. The other dry matches the Engineer had, so we buried ourselves in the sand to keep warm and went to sleep.

The next morning (7 June 44) I had walked down the beach about a mile and found one inland river. The tide was running in and the wind was with us so we all got in the dinghy and expected to sail up this river to a native village. We passed a single straw hut, but went on thinking we could find more life.



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We sailed until approximately 0800Z when the river came to an end and we found nothing. The Bombardier caught 3 crabs and we ate them. This helped our thirst a bit, but not much. On the way back we stopped at the thatched hut we had seen before and looked for life, but found none. We stayed there toolong because the tide stopped going out toward the sea and we had to row back approximately five miles to where we landed the night before. We were all very thirsty and the candy charms we had relieved our thirst a great deal. We were tired and really slept well that night. About 1800Z we got up to catch rain water, but though heavy clouds passed us by it failed to rain. About 2200Z (7 June 44) we heard a whistle and it was the five men from the other dinghy coming in a native boat to pick us up. We went to the native village and had a delicious meal and rested until a PBY came and picked us up. While in the village we learned that the matches in the E-3 kit were safety matches and the striker was on the inside of the top. The E-3 kits should be water proof because everything was ruined with the possible exception of the matches.

Engineer - 2nd Lt. J. E. Phalen

I had 150 feet of electric wire along so I tried to partially rewire the transfer system and it worked for a few minutes. I then commletely rewired the system and it worked for a few minutes again. However, it burned out for good this time and nothing could be done.

The Pilot asked to be wired into his seat which I did, but later I understand the Co-Pilot talked him out of this plan. I was wearing a homemade vest with first aid equipment, food, survival equipment, etc. I also had ready to take with me a full canteen of water, an ax, and a first aid kit, I braced myself for the impact withmy head against the armor plate. We touched the water twice very lightly and I cut the switches just before the final impact. The pilot did a fine job of landing the ship. The water rushed in so fast that I just had time to get myself out. I had nothing withme except the homemade life vest I had on.

The Radio Operator was next to me braced against the armor plate by the Co-Pilot. He moved after the second slight touch. I put my hand on his shoulder to restrain him, but was unsuccessful. He was getting up to pull the life raft releases. I am almost sure the upper forward turret cover is what hit him.

I climbed up on the wing and the Co-Pilot gave me a life raft and I started picking up the crew. I ran across the Gibson Girl Radio floating in the water so I put in in the Dinghy. We tried to reach the Radar Operator and Left Gunner, but were unable to because of the high sea. While we were trying to reach them I looked back and saw the ship go under. It stayed up about 20 minutes. The severed tail section sank first.







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The rest of the experience is just as the Co-Pilot has related. I wish to say, however, that we would have been in a bad way if we had not had the medicines and the life vest I was wearing. I feel that this vest had a great deal to do with saving two boys lives. This seems to be the most logical way to carry escape and survival equipment. For example, when I got out of my escape hatch I had both hands free to work and not full of miscellaneous equipment. The book on survival at sea in the vest was a great help. I took a suggestion for distilling water from it when on land and it worked with only meager success, but it was worth it. I wet a sock with sea water and stuffed it in the mouth of the plastic water bottle and then poured cool sea water on the outside of the bag. I got a little water, but not much. I mixed it with the lemon extract powders I had and this made it taste better. Probably, if I had worked longer I would have gotten more water, but the steam we were distilling from the heated water in the oxygen bottle was a better method so I gave up. The candy charms are very good for thirst and seem to relieave a "cotton mouth" almost immediately.

Bombardier - 1 t Lt. B. F. Wontika

I placed my Navigation brief case in front of the bomb site to prevent it from snapping off and going through the nose of the ship. I thenwrapped my B-10 flying jacket around the bomb site. I went to my ditching station in the gunners compartment and bracedmyself against the bulkhead leading into the bomb bay. I locked my hands behind my head and put my head and elbows between my knees. The gas fumes were intense just before we hit. I had an E-3 kit in my pocket and a full canteen of water on a web belt. However when the ship exploded and I went down in the water I lost them. I came up under the bomb bays and saw yellow flame and smoke so I ducked under the water and swam clear of the ship. I was the first man in the Engineers raft.

The rest of the story is the same as the others have told. I want to mention, however, that the candy charms are a great relief from thirst and that I worked almost all night the first night on land to dig a well. I got it about arms length deep, but no water, I rested a few hours and when I went back it was full of salt water.

C.F.C. Gunner - Sgt. M. E. Belcher

I braced myself against the rear bomb bay bulkhead and heldmy hands behindmy head and my elbows and head between my knees. I braced my feet against the CFC stand. I had a pistol, full canteen of water, knife, and an E-3 kit. The gas fumes in the rear of the ship were very nauseating before the ship exploded. I must have gone through the bottom because I found myself in the water about 15 yards from the airplane.



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I inflated my Mae West and waited until I was picked up. My canteen of water did not have a cork stopper in the cover and as a result it was full of salt water and gasoline. The Engineer thought it was best that we get rid of the water so we wouldn't be tempted to drink it later when we were thirsty, so we poured it out.

The rest of the experience is just as the others have said. I ate malted milk dextrose tablets and a D-ration bar the Engineer gave me from his vest, the first night on the water. The D-ration bar and tablets I had in my E-3 kit were salty and soggy, because the kit was not waterproof. I was afraid to eat them for fear they would make me thirsty. The waterproof medicines and concentrated food the Engineer had certainly saved us.

I wish to say the natives certainly treated us well and should be rewarded for their hospitality in some way.

Left Gunner - Sgt W. W. Wiseman

I was not in my proper ditching position because the Co-Pilot had ordered me to open the rear escape hatch so we could get some relief from the heavy gas fumes that were in the ship. I opened the escape hatch and had started back to my position when I felt the taillightly touch the water. Realizing that I might not have enough time to get to my post I lay down on one of the cots in the radar compartment and braced myself for the impact as best I could. I held my head as solid as possible against the cot frame-work. From here on everything is blank. The other crew members told me I was blown out of the ship. I remember I was under water so I swam to the top, but must have passed out again because I again found myself under water. I inflated my Mae West and came to the surface. I know I was very weak and really don't remember what happened for quite sometime. I did see the dinghy and thought they were coming to pick me up. I never realized that they were having a hard time reaching me. Night came on and I heard someone hollering so I yelled also. I foundout it was the Radar Operator. I told him to keep yelling and we would be able to get together. We almost bumped heads before we realized we were so close. He had found an oxygen bottle from the ship and had it under his arm. The heavy sea we were having at this time was responsible for his taking in so much salt water. The position he had assumed on the oxygen bottle was causing him to take in a lot more water than was necessary (The Radar Operator does not know how to swim) so I told him to take it out from under his arm and straighten up in the water. This he did. He kept complaining of the pain he was suffering and that he thought he was going to drown in the high sea. The squall grew more intense and the waves tossed the Radar Operator around so he could not catch his breath. I had him hold the oxygen bottle at both ends with his







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hands and then I would grab him around the waist and push him up on the bottle. The collar of his Mae West would catch on the bottle and he would ride this way for a few minutes and be quiet. I was unable to hold him up like this for more than a fewminutes because the waves would prevent me from breathing while they were breaking so fast. I would then let him go while I caught my breath. He would start screaming again so I kept repeating this operation. (The Left Gunner weighs approximately 125 pounds, the Radar Operator weighs approximately 160 pounds). I was getting tired so I dropped my shoes and full canteen of water. I figured that the canteen the Radar Operator was wearing would be enough for both of us. After we were in the water a few hours crabs began eating on my neck and arm and the Radar Operators legs. I could brush them off fairly well, but they caused my companion a great deal of pain. They just wouldn't leave us alone. I think this had a great deal to do with his becoming delirious.

Just shortly after we had weathered our second squall during the first night, the Radar Operator went out of his head and was delirious from the pain of his injuries. We had just taken a drink from his canteen when he pulled his knife out and wanted to kill us both. I was very scared and was afraid he might succeed. I had more strength left than he did and managed to get it away from him. He also wanted to pull his Mae West off. I had lost a lot of strength by now and if he hadn't decided to quiet down I think he would have finished us both.

A little afternoon we were picked up by the dinghys. At this time I found out about the cuts in my neck, head, and arm. I was not aware of them before. I don't remember much of what happened from then on because I was pretty groggy. The candy charms helped my thirst a good deal. I understand if the Engineer had not had that life vest with the waterproof drugs I might have gotten blood poisoning and lost my life. This seems to be the best way to carry essential supplies.

Conclusions

1. A calm sea resulted in an excellent landing being accomplished.
2. There was an explosion in the rear bomb bay causing the ship to break open at the radar compartment -- obviously the result of the gas fumes.
3. Emptying bomb bay tanks through closed bomb bay doors is not advisable.
4. The pilot and co-pilot should be equipped with shoulder harnesses for crash landings.
5. Ditching procedure should be revised taking into consideration the following points:

   a. Removal of turret covers.
   b. Eliminating the radar compartment as a ditching station.



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c. Taking the bombsight off its stand because there is a good chance it will snap off, and go through the plexi-glass nose.

d. Safety bars for bulkhead doors leading into the bomb bays so they won't fly open and permit loose equipment and water to come rushing in.

e. Chopping out the CFC blister to provide an additional exit.

6. Crew discipline was excellent.

7. All crew members expressed their appreciation to Lt. Jones, Ass't S-2 for the life vest he loaned the Engineer. They felt it had a great deal to do with preventing blood poisoning and possible death of the two injured men. All hoped that a similar vest could be developed for all flying personnel.

8. Hard candy charms are a great relief for thirst.

9. Life raft compartments should be enlarged to accomodate at least a minimum supply of water and first aid equipment.

10. If a vest cannot be developed then all money belts should include at least 2 powder packets of sulfanilamide and 2 morphine syrettes because this is one piece of survival equipment that all combat crew men wear.

11. All personnel felt that the Left Gunner had done a wonderful job of self sacrifice beyond the call of duty in saving the life of the Radar Operator.

12. All members would like to see the natives rewarded for the excellent care they took of them.

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HEADQUARTERS 40th BOMBARDMENT GROUP LES/gnz
Office of the Intelligence Officer

APO Number 631
8 June 1944

Narrative of Ditching by Crew of A/C #282

B-29 aircraft #282 of 395th Bomb Sq took-off at 0032 5 June 44 from APO #631 in accordance with FO #2, 58th Bomb Wing, dated 2 June 44. On returning alone from mission the ship was forced to ditch at approximately 0950Z at position 21° 46'N - 91° 53'E. Mechanical failure of fuel transfer system necessitated ditching when gas supply in wing tanks was exhausted.

At the time of ditching combat crew of the aircraft consisted of 11 men, 7 of whom were rescued and 4 lost.

| Position | Name and Rank | Status |
|---|---|---|
| Pilot | Capt J.N. Sanders | Rescued-Uninjured |
| Co-Pilot | 2nd Lt. W.C. Burrows | Rescued-Uninjured |
| Bomb Nav | 2nd Lt. W.E. Eckelman | Rescued-Uninjured |
| Nav Bomb | 2nd Lt. S. Fishman | Dead |
| Flt Eng | 2nd Lt. C.H. Moore | Rescued-Uninjured |
| Radio Mech | S Sgt. C.A. Mack | Rescued-Uninjured |
| Radar Mech | 2nd Lt. W.S. Plattenburg | Dead |
| Senior Gunner | Sgt. J.J. Drenk | Rescued-Uninjured |
| Right Gunner | Sgt. D. H. Capshaw | Rescued-Injured |
| Left Gunner | Sgt. C.A. Baker | Dead |
| Tail Gunner | S Sgt. N.A. Brothers | Dead |

Five (5) of the surviving combat crew members returned to APO #631 by airplane on 8 June 1944 and were interrogated on landing. Sgt Capshaw remained in the RAF hospital at Chittagong with a hip injury and 2nd Lt. C.B. Moore had remained at Chittagong to identify bodies that had been found. The following are the individual narratives of the five crew members interrogated.

Pilot - Captain J. N. SANDERS

At the time of ditching the sea was very smooth and the aircraft slid into the water with no jolt or jar. It slid along for perhaps 10 seconds and then came to a sudden stop (little or no crash effect was noticed by the Pilot, but



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other crew members reported severe shock). The Pilot looked around to see if other crew members were O.K. and since everyone in the front of the plane seemed to be uninjured and moving he crawled through his window out on the top of the fuselage. He noticed that the rear hatch behind the radar compartment was not open and ran back to it to try to get other crew members out of the aft part of the plane. He encountered considerable difficulty in opening the hatch, but was finally successful. He found the life raft inflated and blocking the exit so that Sgt. Dronk whom he could see below was unable to get out. He was able to cut the life raft loose with his trench knife and pull Sgt. Dronk out. The Pilot reported looking in but could not see anyone. Water was within a few inches of the hatch. He noticed that although water was within a few inches of the hatch, the front of the plane was higher in the water than the rear and that the tail gunners compartment was well above water and the water was only up to the top of the horizontal stabilizer.

The Pilot could see Sgt. Capshaw's head up in the top blister and noticed that Lt. Burrows and Lt. Moore were trying to remove the blister. As they were starting to work on the blister, Captain Sanders noticed that the left life raft which Lt. Moore had gotten out was floating away so he told Lt. Burrows to work on getting the blister off and he jumped in the water, secured the raft and brought it back to the plane and tied it. He then found Lt. Burrows and Lt. Moore had removed the blister with the aid of trench knives and by kicking it out. Sgt Capshaw could not get through the opening and was in terrible pain from his hip injury. They tried pulling him through, but this evidentally so aggrevated the pain that Capshaw went temporarily berserk and fought them violently. Captain Sanders observed that Capshaw had on his belt with canteen, knife, first aid packet, etc., attached and that his Mae West was inflated, all of which was preventing his getting through. They managed to get the belt and Mae West off Capshaw and pull him through although Capshaw continued to fight violently. The pilot noticed that the plane seemed to have settled a little more in the water and was afraid it was nearly ready to sink. They put Sgt Capshaw in one life raft and Captain Sanders got in with him. The four (4) other crew members got in the second life raft which had been pulled over on the same side, and paddled away from the ship. They were in the rafts for about 45 minutes when they were picked up by a high speed launch from the ASR station at Chittagong.

While still on the ship they noticed two (2) "Spitfires" circling over head, one of which departed and led the launch to the plane. Just as they had gotten into the launch, the Pilot noticed a "Spitfire" buzz the plane and looked over to see Lt. Eckelman coming out of the top blister.





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Captain Sanders and Lt. Moore returned to the plane in a dinghy, taking several axes with them. They chopped holes into all compartments in order to make sure no one else was left aboard alive; since no one else was found they returned to the launch with Lt. Eckelman.

Bombardier Navigator - 2nd Lt. W. E. Eckelmen

Ditching station was in gunners compartment. At shock of impact the rear pressurized door burst open and water flooded into the compartment. He was stunned momentarily and came to with his feet up in the air. He recalls Lt. Fishman going through the door into the radar compartment hollowing "Come on out this way", and stated that Lt. Fishman seemed to be uninjured and very calm. He heard Sgt. Capshaw cry out that he could not get up so he reached over and pulled him to his feet, then started through into the radar compartment. He remembers that Lt. Fishman went into the radar compartment first followed by Sgt Drenk, the senior gunner. Capshaw tried to go through but could not get by the armor plate and the cots which were down and stepped back telling Lt. Eckelman to go ahead. When he went through the door, he stated, both Sgt. Capshaw and the left gunner, Sgt Baker seemed to be O.K., but he had a hard time getting between the cots and the armor plate door and finally blacked out.

When he came to he heard the sound of an airplane engine (later identified as one of the "Spitfires" overhead). He was tangledin control cables and the smell of a gas was very strong, burning his nostrils, eyes, and skin and making breathing difficult. He pulled out his gun and fired 2 shots through the fuselage to attract attention, after which the gun jammed and he lost his clip with the remaining 5 shells in the water when he tried to fix it in the darkness. He then realized that he was caught between the armor plate doors and the cots but was finally able to work himself loose.

He turned and was able to see that the top blister was off. Finally he managed to open the armor plate and get past it into the gunners compartment and out the blister hole after removing his belt which at first prevented his getting through. He climbed out on the fuselage and was taken off as related by Captain Sanders.

Radio Mechanic S/Sgt. C. A. Mack

Upon orders from the Pilot Sgt Mack took his ditching position along side the flight engineer. The flight engineer had removed his escape hatch door and Mack took it, opened the pressurized door leading into the bomb bay, and threw the hatch cover in. He had difficulty in securing the door again, but was positive he succeeded in locking it shut. He heard the





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ship slide into the water, saw the Flight Engineer throw the ignition key and push through his escape hatch before the ship came to a stop. When the crash came the pressurized door into the bomb bays burst open and water flooded in. The dome on the upper forward turret dropped down, nearly hitting him. He was struck by various articles flying about but retained consciousness. He remembers asking the Co-Pilot if he should pull the life raft releases, and upon being told to do so he pulled the right raft release twice and the left raft release once. He noticed that there was no water in the tunnel and he called for those in the rear to come forward but received no answer.

He returned to the Flight Engineers escape hatch and noticed Lt. Moore, the Flight Engineer on the outboard side of the #4 engine on the trailing edge of the wing in the water. He got through the engineers hatch into the water and inflated the Mae West, then climbed up on the wing between the inboard engine and the fuselage. By this time he saw Lt. Moore getting out the left life raft so he proceeded to try to get out the right raft. He tried to inflate it but it only inflated a little; he tried again, but only succeeded in inflating it a little more. He finally managed to tug it loose and found it was about 3/4 inflated. Lt. Burrows called for the raft so he put it over the sides, jumped into the water and pushed it along the fuselage to the point opposite where Lt. Burrows was standing. They tied the raft and Lt. Burrows helped him up on the fuselage where he helped with Sgt. Capshaw. After pulling the right raft over on the left side so all could be together and helping Sgt. Capshaw and Captain Sanders into one raft, he got into the other raft after Sgt. Drenk and Lt. Moore, and was followed by Lt. Burrows.

Senior Gunner - Sgt. J. J. Drenk

After the shock of landing Sgt. Drenk did not remember anything until he found himself caught by his belt on cots and armor plate door in the radar compartment. When he came to he went out through the door of the radar compartment into the unpressurized aft compartment where he could see Captain Sanders tugging at the life raft blocking the hatch. Captain Sanders pulled him out as related. Everything was very hazy until he found himself on the fuselage.

General

ASR personnel took crew to Chittagong where they were all hospitalized and every comfort was provided. The following morning Captain Sanders was advised that the B-29 had beached itself on a sand bar just off shore.



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It was not until 7 June, however, that, accompanied by Lt. Moore, Lt. Col Wilson, Maj Hammond, and the Wing Salvage Officer and Captain Sanders returned to the ship. He found the ship broken in two at the radar compartment. He searched the plane for bodies but none were found. It was determined what could be salvaged and the loose equipment was picked up. A study was also made of what had broken loose on impact.

Captain Sanders reports the nose of the airplane unbroken and the wheel well doors intact. The Secret and Confidential documents were removed from the plane, as was the secret equipment. Captain Sanders crawled through the tunnel which was still intact. In the gunners compartment the senior gunner's stand was badly smashed, floor boards ripped up, but the bottom of the plane seemed intact. The upper turret cover of the aft upper guns was off. This is almost directly above where the radar operator and the tail gunner had ditching stations.

## Conclusions

1. A smooth sea undoubtedly resulted in an excellent landing being accomplished.
2. Ship ditched close to shore in about 30' of water.
3. Pilot showed sound judgement in taking every precaution against ship falling into hands of enemy, but should have known field at Cox's Bazar was in Allied hands. Enemy front lines will be stressed in detail in future briefings.
4. E-3 Kits which all crew members had in leg pocket of flying jumpers should contain morphine. Had ditching taken place further out to sea the problem of handling a pain crazed man without morphine could have been very serious. First aid kit in life rafts should also contain morphine.
5. Ditching procedure as now outlined worked very well for forward part of ship but not for aft.
6. Some sort of escape hatch is needed in gunners compartment.
7. The cots in the radar compartment are very much in the way and could be dispensed with.
8. The armor plate door leading into radar compartment makes entrance and exit very difficult.
9. Gas in gunners and radar compartment should be investigated to see if possible to eliminate source thereof.
10. Better escape facilities from gunners compartment and radar compartment should be considered.
11. All crews should be briefed not to jump to hasty conclusions as to whether or not anyone left inside ship is still alive. Case of Lt. Dekelman in this narrative.
12. Discipline on the part of all crew members was good.



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13. The chances of injury in B-29 water landing by motors, etc., breaking loose upon impact from mountings inside ship are very high, especially in any kind of a heavy sea.

14. The rear pressurized door should have some sort of extra support to prevent its bursting open and flooding compartments.

15. The B-29 continued to float and the tide washed it up on the beach. If ship does not break up on impact, it stands a good chance of staying afloat for some time.

16. No one could explain what had happened to Lt. Fishman, last seen entering the radar compartment and evidently uninjured, or the left gunner, Sgt. Baker, last seen uninjured in gunners compartment.

17. The radar operator and tail gunner may have been killed or rendered unconscious on impact through being struck by flying debris.

18. Domes covering both forward and aft upper turrets should have some sort of safety catch to prevent their falling off on impact.

19. Captain Sanders does not feel that the radar compartment is a good ditching station.

20. All crew members returning this station expressed themselves as most grateful to the ASR and other personnel at Chittagong for their unlimited courtesy and consideration as well as their efficiency in handling the rescue operation.

LOUIS E. SCHERCK,
Major, Air Corps,
Intelligence Officer.

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Headquarters 468th Bombardment Group
Office of the Intelligence Officer
APO 493

SECRET
Auth: CG XXIBC
Initials
Date

11 July 1944

SUBJECT: Report of Crew of A/C 42-6314 -- Lt. Sloan, Pilot.

TO : Commanding Officer, 468th Bombardment Group, APO 493

1. On 8 June 1944, B-29 42-6314 took off from A-7 at 0538, local time, returning to B-1. On 3 July 1944, Wing at A-1 received word from Chinese sources that ten members of the crew were walking out from an area to the southwest of I-Pin. These ten reached I-Pin on 6 July 1944. The next day they were picked up by a C-46 and taken to the AAF hospital at Cheng-Tu. The loading list of A/C #314 on 8 June 1944 was as follows:

Crew of A/C #314, 793rd Bombardment Squadron, 468th Bombardment Group.

| | | | |
|---|---|---|---|
| 1st Lt. | Leslie J. Sloan | 0-794710 | |
| 2nd Lt. | Frank W. Holmes Jr. | 0-443985 | |
| 2nd Lt. | Vincent R. Casazza | 0-811554 | |
| 2nd Lt. | Charles B. Grey | 0-664611 | |
| 2nd Lt. | Robert E. Carey | 0-665159 | |
| S/Sgt | William C. Sene | 16043658 | |
| Cpl | Virgil W. Bailey | 6273178 | |
| Cpl | William L. Shufelt | 35624680 | |
| Cpl | John H. Moore | 6961416 | |
| Sgt | Frances P. Reed | 12165680 | (Killed) |
| 2nd Lt. | Carl B. Ray | 0-752082 | |

2. On 10 July the members of the crew were visited and interrogated at Cheng-Tu by Major George P. Putnam and Lieutenant John V. Phelan, 468th Bombardment Group Intelligence, accompanied by Captain Paul Frey, Wing A-2, and Captain H. M. Berry. In the following report the information secured in those interviews is set forth:

Lieutenant Sloan, Pilot, gave an over-all picture of the accident itself, and its aftermaths, which was substantially concurred in by all members of the crew, all of whom were interviewed.

At "about nine o'clock India time" Senior Gunner Shufelt reported over the interphone that there was a fire in #3 engine. Almost immediately an explosion occured in the engine, which shook the whole ship "with a definite jolt". The Engineer released the extinguisher and apparently the actual fire was put out. The plane had just leveled off at about 22,000 feet, flying above an undercast, with power setting 2300 and 38 inches. It was Sloan's opinion, shared by the engineer and Senior Gunner that it was a piston which went through the cowling, tearing a jagged hole about a foot across, in the top center of the cowling. Sloan pulled back power and hit the feathering switch. The engine started to feather and went down to about



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900 rpm. Then it went back to about 1400 rpm. Sloan turned the ship over to Co-Pilot, ordering 180 degree turn, which was made while Sloan and the engineer tried to get control of the engine, which would not feather. The engineer shut off mixture control and shut off gas line. Meanwhile the other three engines were functioning normally. Air speed fluctuated between 150 and 200 mph. "Manifold Pressure" said Sloan, "went up, though I can't explain it, as with the switch cut off no gas was going to the engine.

About four minutes after the explosion #3 prop started to run away. It got between 2300 and 3000 rpm and the plane commenced to shake terrifically. The facts as described in the two quotations from Sloan were substantiated by the Co-Pilot and Engineer.

The aircraft was losing altitude, apparently several hundred feet a minute. Sloan directed all hands to prepare to abandon ship, and released cabin air pressure with the release situated beside the pilot seat. Sloan then lowered the wheels and told all hands to bail out. The men in front went down through the front-wheel well. Those in the rear went out through the door beside the put-put, except the tail gunner who used his emergency exit. All went out feet first, those in front in the following order: Bombardier, Navigator, Engineer, Radio, Co-Pilot, Pilot. Sloan believes the ship was at about 20,000 feet when he left it. He believes fire had resumed in the engine, though others do not all agree. Certainly oil-smoke appears to have been pouring through the hole in the top of the cowling.

Sloan believed everyone had left the ship when he jumped. Actually, one man, Sgt Frances Reed, left gunner, never left the plane. His companions in the aft section saw him with his chute on, and supposed he would jump following the right gunner. But Reed's body was identified subsequently by two crew members at the wrecked plane.

Sloan says that after bailing out, the last he saw of the aircraft "she was flying straight and level". He had not set automatic pilot. Descending below the undercast Sloan saw "seven or eight" of the others on their way down. He landed northeast of them, possibly several miles. During the drop, and in the plane immediately preceding, after it had been depressurized, no one reported ill effects from lack of oxygen, and no one blacked out from lack of oxygen when chute opened or sustained major injury on landing.

Sloan's own landing, however, was not easy. He said: "On the way down you have a sensation you're going to float forever. Then when you begin to near the ground, you realize you're going in a hell of a hurry. I struck a good sized tree, crashed down through branches and finally hung about 15 to 20 feet above the ground, my chute caught in upper branches. I pulled in to the trunk, using branches to help me, unbuckled the chute, and unfastening the jungle kit, I let it drop, scrambled down the tree trunk and then slid down a steep slope to where the kit had landed."





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Shortly, Sloan heard Chinese voices. He fired his forty-five, but had no response. Descending further, at the base of a cliff, he saw a Chinese who waved to him to come down. Thereafter he fell in with three Chinese, one about 35, one perhaps 18 and a boy. None spoke English. Sloan's pointie-talkie contained only Burmese and was useless. Hearing other voices, the Chinese directed him to be still.

The Chinese took him to a house at the end of a trail, which they reached after scrambling through thick growth, so wet he was soaked. It was a mountainous country, with steep slopes and cliffs and jungled undergrowth, with maximum altitudes, Sloan thought, of about six or seven thousand feet.

After sleeping a couple of hours at the house (Sloan was exhausted) he insisted on going in the direction of the plane. Already there were odds and ends of wreckage scattered along the trail indicating natives had been carrying off what they fancied.

Sloan and his friendly companions were joined by others, smaller men, not so flat-featured as the Chinese, apparently more Mongolian in appearance, and doubtless members of the Lolo tribe.

"They were pretty rough lads", said Sloan. "They tried to take away my forty-five, but I managed to keep it". He was assisted by the young Chinese, whose name phonetically spelled, was Sadingtou.

Sloan was then taken to the Chief's house. Sadingtou, and the rest of them, smoked opium and invited Sloan to join which he refused. Sloan was then taken to another settlement, fed rice and pork, and some of his remaining rations were taken away from him.

The next day Sloan was discouraged from moving off, and all hands rolled opium pellets and hit the pipe. "Time meant nothing" said Sloan. "I tried to find out bout the rest of the crew, and tried to get started to the wreck but could do nothing."

In the evening of the second day they finally moved on to another village. On the third day, Sadingtou (who was pretty consistently befuddled with opium) indicated with pantomime that nine men of the crew were safe, one dead.

That evening Sloan finally contrived to get the others to take him to where seven of the crew members were, two of them, at the time, having gone to the wreck of the plane. Returning, these two, Moore and Shufelt, told Sloan they had found the body of Reed in the wreck, positively identifying it, although everything like watch, tags, belt etc had been removed. (This was two days after the crash, and the first time any crew members had been able to reach the plane. The following day, the local Lolo chief stated that the body had been buried, near the plane.

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The next eight days were spent in "hanging around". Sloan and the crew apparently were unable to get any action and were discouraged, almost forcibly, from getting under way. They did not apparently, make any direct offers of reward which would be paid if they were safely delivered to friendly Chinese. In the meanwhile, (as indicated in subsequent interviews) several of the men were robbed of everything they had except their clothes. All but two money belts were stolen. And the bad condition of Holmes leg, badly bruised, further contributed to the difficulty of getting started. Incidentally, the blood chit made no impression on these people. They seemed to like the Chinese as little as the Chinese like them.

On the 11th day they were told they could start. The Chief gave them one of the jungle kit frying pans, full of opium paste, to help them pay their way as they went along, and one of the stolen mosquito nets, full of popcorn.

That night they stayed at a house across a mountain ridge, where a pig was killed to feed them. Despite the wildness of the people, all tillable acreage of the region seemed to be farmed.

The night of the 12th day they stayed at another house. That day, CAU, planes passed over head and they signalled with mirrors. They walked each day they were moving from ten to twenty miles. In all, they think they covered about 200 miles. GI footwear with rubber soles proved first rate in every way. Extra socks were recommended for inclusion in the jungle kit.

The 13th day following the crash they reached a Chief's house, near the river. There, in the valley, they encountered the first mosquitoes. Their best protection was what they could devise from a parachute and a half, all that they had been able to keep from the Lolos. The big treat at this valley chief's house was round flat pieces of hard brown sugar, which tasted very good indeed after the pork and goats meat and potatoes they had been eating almost exclusively, for most of their rations had gone to the Lolos.

There they stayed four nights. Then in a boat they "crossed a rough, fast river", and a lad whose name sounded like Shunway, joined them. The new friend warned them "the people in the town (where they were headed) are not to be trusted". At that town three Chinese soldiers, one of whom spoke a little English, tried to persuade them to go with them southward. But Sloan and the others distrusted their intentions, and they stuck with their Chinese companions and continued to head for Loipo.

The day before they finally reached Loipo, as they were following the river, shots were fired at them from the opposite bank. The Chinese boy indicated they should wait until darkness came-- all hands were down behind protecting rocks-- but after a few hours, firing having discontinued, they moved on.







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That night was spent on the river bank opposite Loipo. In the morning they crossed by boat, and reached Loipo, where the Chinese Magistrate treated them handsomely, caring for them at his house, providing good food, boiled water and even having their clothes washed.

From Loipo three stretchers and an armed guard accompanied them all the way to I-Pin. On the second day out from Loipo part of the Chinese guard went ahead. They, and some merchants moving with them, remained with the balance of the troops. Shortly there was firing ahead. Then a bugle call, and they moved on. The bodies of several freshly-killed Lolos were encountered, and the head of one was displayed on a stake, to the obvious satisfaction of the soldiery and the merchants, whom the Lolos apparently had a habit of robbing along this special stretch of road.

Co-Pilot Ray said he saw "a jagged hole about 12 inches across in top of cowling. Smoke was pouring out at time he jumped, and he believed fire had started again. When the chute opened, either my 45 or the buckle hit me in the head and I was nearly knocked out. Looking around he saw Bailey going down very fast. It looked as if half his chute was gone." Actually three panels had ripped out) On the ground the natives took everything we had.

Engineer Casey said he believed "something in #3 engine blew up or gave way. Perhaps a band gave way and a piston went out. He did not think the engine was on fire when they jumped.

Tail Gunner Moore was one of the two men who saw the wreck of the plane. It struck on a steep slope, apparently headed down the slope, almost in a diving position. Everything about the aircraft was demolished, scattered in small fragments. Apparently there had been an explosion and considerable, though not a consuming fire. He saw no papers or identifiable parts of secret equipment. He saw and positively identified the head of Sgt Reed, though no tags or other personal items had been left by those who evidently had taken away everything they took a fancy to, in the two days intervening between the crash and the visit of Moore and Shufelt. Reeds body was unburned. Both legs were severed above the ankles. One foot was found 100 yards distant, the other foot, and a severed right arm lay near the body.

Senior Gunner Shufelt substantiated Cpl Moore's statements. He too said he definitely identified Reed. At time of explosion while in flight he said he saw something go out of the top part of cowling apparently over rear row of cylinders. After the effort to feather had been unsuccessful, he said "the vibration in the back of the plane was very severe". Before jumping (he was first out of the men in the rear) he saw Reed with his chute on and could offer no reason why he failed to jump.

Right Gunner Bailey was last to leave the rear exit. One foot caught and he was flattened against the fuselage by the slip stream, and succeeded in getting free only the greatest effort. When he did get clear and pulled the rip cord, three panels of his chute were ripped out. It was a smooth tear and was not jagged. He does not believe that it tore when he jumped.



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The chute had been repacked a few days before this mission. He believes no injury to the chute was sustained while he was hung up in the door. Despite the speed of his descent, he suffered no material injury when he struck the ground. Like Shufelt, he saw Reed apparently ready to jump Normally, Reed would have followed him to the exit. Had Reed reached this exit, he would have helped Bailey get free, but Bailey got no such help. The ship at that time was not moving violently, this in the opinion of Bailey and Shufelt, minimized likelihood that Reed was thrown about and possibly rendered unconscious by striking his head.

Bombardier Cossozza and Radar Officer Gray supplied no information at variance with the general story as outlined above.

Lt. Holmes, Navigator, reported that the explosion occurred at 0229Z (0929 China time). He placed the time in relation to his ETA at HsiChang which was their first turning point and which they had just reached when the fire broke out. He said that the ship continued on course instead of making the turn and then turned into a heading of 10° back toward A-7. He did not have his chute adjusted properly and he was knocked out by the jolt when his chute opened. He came to just before he hit the ground, but landed hard on a rock and was knocked out again. When he came to again, he found that everything was gone including his ring, wallet, money-belt, and 45 automatic. He still had his chute but this was taken away shortly afterwards by one of a party of seven Lolos all armed with rifles.

S/Sgt Sene, Radio Operator, gave a routine position report to Kunming by voice on 5530 KC and obtained the usual clearance to proceed just before reaching HsiChang. He then changed to another frequency to call A-7. Before he could get tuned in, the emergency arose and he swung back to 5530 KC and gave their position (approximate) and heading (10°). As the others were bailing out he did not await a reply. He doesnot know whether the message was evenreceived and did not say that they were bailing out. (Note: It is possible that he did not get tuned in again to 5530 KC as we have never been advised that any such message has been received at Kunming or elsewhere)

Attached to the report is a sketch showing the location of the accident and the route taken by the crew to I-Pin.

/s/ George P. Putnam,
GEORGE P. PUTNAM,
Major, Air Corps,
Intelligence Officer.

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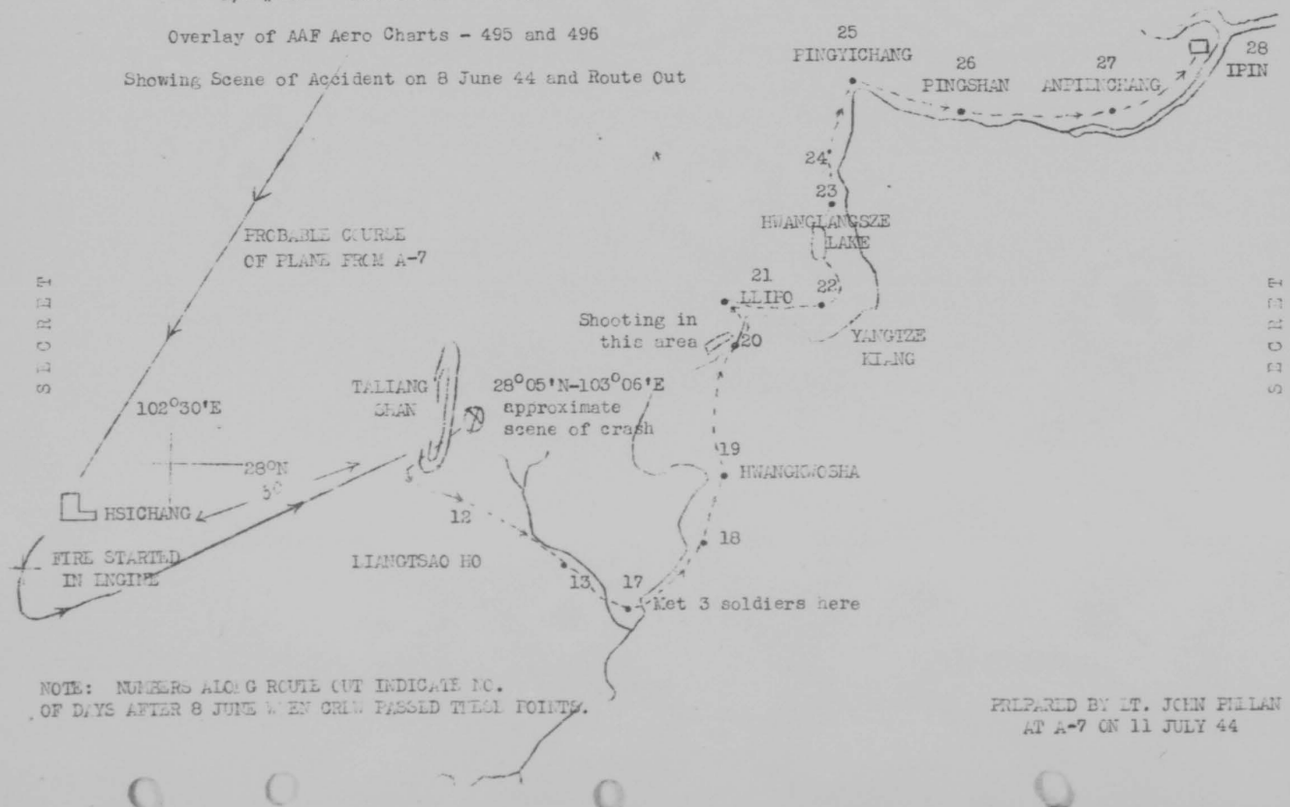
A/C #314 -- Lt. SLOAN -- Pilot

Overlay of AAF Aero Charts - 495 and 496

Showing Scene of Accident on 8 June 44 and Route Out

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NOTE: NUMBERS ALONG ROUTE OUT INDICATE NO. OF DAYS AFTER 8 JUNE WHEN CREW PASSED THESE POINTS.

PREPARED BY LT. JOHN FILLAN
AT A-7 ON 11 JULY 44

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FORWARD ECHELON
HEADQUARTERS
444TH BOMB GROUP

* * * * * * * * * * * *
* SECRET *
* Auth: CG XXBC *
* Initials [illegible] *
* Date 4-11-00 *
* * * * * * * * * * * *

12 July 1944

SUBJECT: Report on A/C 42-6246.

TO : Commanding Officer, 444th Bomb Group,
APO 215. Attention: S-2.

1. This is a report on B-29 aircraft number 42-6246, piloted by Capt. Wayne T. Mann of the 679th Squadron, which went down in China on 28 June 1944. All the crew were saved, and this report is based on the informal statements of Lt. Ira S. Paul, Co-Pilot, and Paul F. Sullivan, Engineer, to Robert N. Chambliss, 1st Lt, AC. Interrogation took place on 12 July 1944. At the time three members of the crew, including Capt. Mann, were in the hospital, while two had returned by ATC to India, including the Navigator. This A/C being a tanker, it only carried a seven man crew.

2. A/C #42-6246 left Kharagpur, India, at approximately 0020Z, 28 June 1944, with a gross weight of around 129,000 pounds. Climb was made on course to 19,000', and the hump was crossed without incident. Engines were all running hot however, and at one time #3 kicked to auto lean and had to be put back on auto rich. As the plane approached Sikang it was necessary to pull 39 inches manifold pressure and 2300 rpm to maintain altitude and flying speed. About 0415Z manifold pressure and rpm dropped on #3 engine and oil pressure went out. The prop was feathered at once. There was an undercast all the way and some turbulence. With #3 feathered #1 fell off at once and the ship started losing altitude in very high country. It also went into a 30° bank. The co-pilot ordered bailout over the interphone, and two minutes later bailed out at about 0417Z. The co-pilot opened the hatch and went out, followed by the Engineer, Radio Operator and Navigator in order. A ground maintenance man and the tail gunner stayed for some reason until the pilot had straightened the ship, put it in a slight circle and jumped. Then the ship mushed and the two men in the tail jumped. Bailouts were from 18,000' to about 12,000'. Position was about 27° 33' N, and 101° 32'E.

3. About 0426Z the aircraft hit a mountain and blew up. Landings were made by crew members on the slopes at about 8500'. The Co-Pilot and Engineer landed close together on a slope. Across the valley they could see a parachute, indicating other crew members. Immediately on landing these two men were approached by Lacying Indians of a color resembling iodine, without slant eyes, and each wearing a long blue robe fastened at the neck. These Indians could neither read nor write. They were not impressed by the American Flag, the uplifted thumb, or paper money. They were impressed by the presence of a pipe, by hard money, and by salt which seemed to be a precious commodity. A large percentage of these Indians have goiters in one form or another. By sending a note the radio operator and navigator were brought across the valley and the four men now together



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were taken to a village, where they spent two and one half days. They were treated well and were the object of extreme curiosity. They slept on mats near a fire in the back of a native hut, and got little sleep because of people coming in. The natives ate out of a community pot. These men resorted to jungle kits and were impressed with the need for more food, and also mosquito repellant in the kit. Only one of them had his money belt. None had the escape kit or any other food. Mosquitoes were thick. Rubberized silk maps were not so much help as some maps which the navigator had in his pocket. By these they determined their position and made known their desire to move. One man, a corporal, lost all his savings in the plane, and men should be instructed not to carry too much money on hump trips. No money was given to natives - just salt tablets, benzedrine, and other items out of the jungle kits. On the morning of the third day these four men started out down stream along a trail seeking a river. Late that afternoon they reached a Chinese Outpost and were welcomed into a compound and fed very well, then taken to Yenyuan, where there was a radio station. The pilot and two enlisted men were there bringing together the entire crew.

4. The crew spent one night at Yenyuan. The pilot had a swollen ankle, later found to be chipped, and after the one night the party set out for Sikang, with Chinese guards and guides and horses. They traveled fast, walking and riding (it was hard to decide whichmethod was more strenuous) and reached Sikang in nine days, sleeping sometimes in villages sometimes in shacks, one night in Hosi with a French Missionary where they were royally fed. They were treated well at all times by the Chinese, and the trip, while strenuous, was not too trying. From Sikang these men were flown to Kunming. There they spent a couple of days and the navigator and radio operator returned to India by ATC. The rest of the men then were told to wait for a C-46, which brought them to A-1. They contacted no one there who seemed to know where they were to go, so caught a ride on a truck to A-3, where they were medically checked and interrogated, and are awaiting transportation to India.

5. These men were impressed by several facts. When parachuting weight is limited and must be distributed. The escape kit cannot well be placed in a position to conveniently carry down. If it can, this should be pointed out. A limited amount of money should be brought over the hump. More food should be in the jungle kit, which should be, if possible, released a hundred feet or more above the ground to lighten weight. In remote places hard money is better than paper money and trinkets are better than money. Salt tablets are good for barter and for the bailout, a pipe seems to be a friendly symbol, mosquito repellant should be carried along. Natives are curious, and if handled in a friendly manner are likely to be friendly in turn.

6. None of this crew were critically injured, though three are now in the hospital. Captain Mann has his foot in a cast, and two enlisted men are under observation for possible injuries to back and chest. All three are at Kunming. All were treated well by natives and brought promptly to civilization.

ROBERT N. CHAMBLISS,
1st Lt. Air Corps,
S-2 Officer.





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INTERROGATION OF 2ND LT. JACK POWERS BOMBARDIER OF PLANE #246

Plane 246 took off from Kharagpur at 0650 IST, 28 June, flew to Sylhet, Jorhat, though radio compass couldn't pick up homing, and on to Chaoua, radio compass picking it up just before it was reached. The hump was covered by a solid undercast, but uneventful, though it was impossible to climb over 20,000' and pressurization wouldn't work.

As Lake Luku was sighted through a hole in the clouds, the pilot warned there might be trouble and for everybody to keep their parachutes on. At 1045, #3 engine went out and was feathered, then immediately #1 went out, but it was impossible to feather it. The landing gear was lowered, and upon getting the order to bail out, I plotted a position and stuffed two maps in my shirt. The co-pilot had opened the hatch and jumped, followed by the engineer and radio operator, so I climbed down into the nose wheel and let go feet first. I waited until the rushing noise slackened and felt descent was straight down, and then pulled the rip cord. The chute opened almost immediately with only a slight jolt. Two other chutes were observed in descent. On landing in a soft patch of grass and bushes at (27°37'N- 101°35'E), with my chute partially caught in the lower branches of a tree, I removed the harness, lit a cigarette, and observed the plane still flying to the South in a large circle. A minute or so later, after losing sight of it, a large puff of smoke and flames was seen to the southwest, as it struck a mountain. My watch which I looked at instantly, showed 1056½.

At the time the order to fix parachutes had come, my jungle pack had not been attached because of the discomfort of sitting on it at the navigation table, and later, in the excitement of bailing out, time was not taken to fasten it on, as I took it for granted that this territory was populated with friendly Chinese, and I saw no need to add the extra weight and awkwardness of it or my pistol. The escape belt and kit were lost in the confusion of bailing out or landing.

Picking up my chte, I started down the mountain towards a stream, fell, and slid about 25 feet, and was picking myself up when two men came running toward me, each carrying a foot long knife. They looked unfriendly at first, but after I smiled, talked, and offered them cigarettes, they became much friendlier, one carrying my chute, the other letting me examine his knife. I made motions for food as a further sign of friendship, so we walked three quarters of a mile to a small village, extremely filthy, with about 25 natives gathering around me. These people, who wore dirty tattered clothes, with long blue capes, were of a dark color, less oriental looking than Chinese, later proved to be Lao-Lao tribesmen, the Chinese considering them very barbaric. They offered me a wooden bowl of the dirtiest uncooked corn meal possible, mixed with cold water. In order not to hurt their feelings, I ate every grain with chop sticks, though each one nearly nauseated me. I started down the mountain with my two original natives when a man with a horse offered me a ride. Some of the people made signs that another man with a parachute was down the stream, so going that way, I found the radio operator with about 50 men and women around him. The people here were very curious, taking everything from our pockets, passing them around, examining them, and then returning them to our pockets. The hair on our arms, of which they had none, fascinated them.







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After hearing three shots in the distance (these proved to be Lt. Paul trying to signal us), we waited around all afternoon until a note from Lt. Paul was brought telling us to join him, and that he had a guide to take us to an American Air Base. It had begun to rain however, so we spent the night in a hut on a pallet, after eating some hot soup and turnip greens. The next morning, the 29th, we were fed baked potatoes, which we considered the most sanitary food. While waiting for the rain to stop, the flight engineer walked in, whereupon we all set out over a mountain to reach the co-pilot.

We took turns riding a horse which one of the natives had. The second afternoon and night were spent in the very small village that Lt. Paul and F/O Sullivan had used the night before. I stayed in a little cleaner hut across the road from the other, the old man giving me his place by the fire. I gave them a small amount of Chinese money on leaving.

On the morning of the 30th, with the people trying to make us stay, we started towards a valley, walking most of the day. Two of the natives who had followed us from the village, let us pile the chutes and jungle packs on the horses. Late in the afternoon, we arrived at a small army outpost with a wall around it.

We were taken to the Chinese in charge of the post, who was extremely friendly and intelligent, giving us Chinese cigarettes, tea and noodles. An hour later, he served us an excellent Chinese meal. We learned that three more of the crew were safe. We spent the night here, and on the afternoon of the 1st, we left for Yen-Yuan, riding horses, reaching it in two hours with the intelligent Chinese as guide. Our names had been taken to Yen-Yuan ahead of us, and here we found Captain Mann, Sgt Lewis, and Cpl Roy. We stayed at a Catholic Chinese Mission that night. While at Yen-Yuan, the barrels of two 50 calibers and the 20 mm, charred with fire, were brought down from the mountain with the report that this was was practically all that remained of the plane.

Sunday, the 2nd, we left on horses, with Chinese soldiers as guards, this having been arranged through the president of the district, who happened to pass through. We rode to a small place where horses were changed, and spent the night in a big stable with horses on one side, we on the other, and a guard between. The food was rough but clean.

After riding and walking all of Monday the 3rd, we spent the night in a small village remount station, sleeping again on pallets, with much noise from some of the natives, making sleep impossible.

The 4th of July was spent riding to Latung, and in crossing the Ya-Lung-Chiang River. This was done in a very crude boat which was pulled quite a way upstream by coolies, then the crew rowed like mad, with the stream sweeping the boat down-stream, but across to an eddy on the opposite bank. While we were waiting for the horses to be brought across in a much larger boat, we bathed and washed our underclothes in the stream, using the soap from the jungle kits. The night was spent in a little town travelling station.

The night of the 5th was spent in Ho-Hoi after riding and walking all day. A French missionary, the first white man we had seen, let us stay at his mission, and treated us royally.





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Hsichang was reached the afternoon of the 6th, after having ridden through a very fertile valley, with the people much cleaner and more industrious. A civilian who was sent out by the Chinese airbase at Hsichang to escort us in, reached us near Latung, but he had been of no help. We were taken to the air base where some American mechanics , who were working on a crash landed B-29, gave us a few supplies, the last that they had.

A radio message sent from here told of our safe arrival, the one sent from Yen Yuan evidentally not having been received.

We were flown to Kunming on the 7th, Captain Mann, S/Sgt Ozbolt, and Cpl Roy were hospitalized. I left Kunming on July 10th, stopping at Calcutta, Kalikunda, and arriving at Kharagpur on the 12th, taking a truck from there to Dudhkundi.

My failure to attach my jungle kit, pistol, escape belt and packet, canteen and pointie-talkie, could have proved very serious had I not been with others who shared theirs with me. They all proved extremely useful.

INTERROGATION OF T/SGT ARLIE F. LEWIS, TAIL GUNNER PLANE 246

I was sitting in the left side gunner's position, on oxygen at 20,000', watching the engines when the order to bail out came. Parachute, jungle kit, and escape belt were quickly fastened and the back door was opened. We, Cpl Roy and I, waited at the back door, watching for the ones in front to jump in order that we might land with them, but caught sight of no parachutes. After about two minutes, I went back to the inter-phone to call the pilot, but on getting no answer, and feeling the plane stall and dive slightly, we immediately jumped, Roy first and then I. We had no trouble getting out, the wind sweeping us clear of the plane. There was quite a jar when my chute opened, slightly straining my back. Immediately after the opening and while I was swinging violently, I saw the plane fly directly into the side of a mountain. It burst into a red flame.

There was another severe shock on landing. I crossed a small hill and finding Cpl Roy, we set off to locate Captain Mann when some Chinese soldiers came running up. I showed them the blood chit which they read, all the time laughing and jabbering, and examining all of our equipment.

We walked over to where some Chinese soldiers were helping Captain Mann down the mountain. They took us to the house where they were stationed and we spent the night there, the mosquitoes keeping me awake most of the night, although the parachutes were used for covering. On leaving, my parachute as given to these soldiers for their kindness. Captain Mann's ankle was badly swollen, so I bathed it in hot water and wrapped it with part of a chute, using the sulphur drug from the jungle kit for a cut on the Captain's chin, and for our scratches. Two halizone tablets were put in every rubber bottle of water that we drank.

The next morning we fed on jungle kit rations and hot tea, then leaving on horses furnished by the Chinese soldiers, we rode 16 miles to Yen-Yuan where a Chinese Catholic Mission was our stopping place for the night. The next day we heard that the other four men were safe and heading for this town, so we waited for them for three days. Though the missionaries treated us very well, feeding us eggs, ripe apricots, and other stuff, the bed bugs, mosquitoes and flies nearly ate us up. The







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people from miles around came to stare at us and examine our parachutes which fascinated them. After the third day, when the other crew members arrived, we left on horses and mules for Hsichang. As I had the GI's for some time, it was a hard trip. We slept in the same room with the horses the first night, with pigs and chickens roosting all around us.

The money from my escape belt was used to buy food and to tip the natives. The silver rupees were given to the women of Yen-Yuan to be used as a pendant. Chinese soldiers acted as our guides for five days on the trip to Hsichang, and they were wonderful to us.

After reaching Kunming by C-46, we had a physical examination, three being hospitalized. Three days later, the 10th of July, I left on a plane with Lt. Powers for Kharagpur, stopping at Calcutta and Kalaikunda, arriving at Dudhkundi on the 12th of July.

Suggested that more food be put in jungle kits, also some mosquito repellant and insecticide. A toothbrush would be really appreciated also.

INTERROGATION OF 1ST LT IRA S. PAUL, CO-PILOT PLANE 246

I jumped straight through the well from the flight deck, falling about 1,500' through the undercast. After my chute had opened, I saw three others open. I landed in a small gully, overgrown with wild strawberries, having dropped my jungle kit from about 200' in order to lessen the weight. A native came down some, leaving two women on the hill watching us, to whom I showed the blood chit from the escape belt. Although he couldn't read and didn't know what thumbs up meant, when I pulled out my pipe, he filled it with his native tobacco and was amazed at the matches I used. His lighter was an old flint and steel. He carried my jungle kit and led me towards other natives and thence to where we found F/O Sullivan. As we could see the others in the distance, I fired my pistol three times, completely captivating the natives.

It rained for thirty hours continuously after we arrived. The natives were very friendly, offering us all kinds of food, most of which we refused.

When Ozbolt and Powers joined us, while I was painting their scratches with iodine, the headsman's wife asked me to fix some sores on her arm, so I painted them until they became the color of her skin, and she thought that I had cured her. When I gave her some salt tablets for her goiters, the headsman got down on his knees and salaamed three times, then brought other patients who I gave salt and benzedrine tablets. The guns the natives carried from Mausers, Luggers, Belgium Brownings, Lee Enfields, to an old gas pipe rifle, and one old gangster type tommy gun.

We started walking Southwest, keeping to the ridges as much as possible, as the people in the more populated places slowed our progress, finally reaching a Chinese Army Outpost, and the next day going on to Yen-Yuan. All along the road, the more intelligent looking people seemed honored by our presence and tried to keep us with them.

The whole crew, which had been reunited at Yen-Yuan, started riding and walking toward Hsichang under the care of a Chinese Army guard. This took five days, spending the nights in remount stations and a mission. The remnants of bridges on the way gave proof of a highway many years old. Two large rivers were crossed by boat on the way.





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We travelled by C-46 to Kunming, stayed there three nights, caught an ATC ride to Hsinching, truck to A-3, and B-29 back to Dudhkundi.

More sugar, salt and tea tablets could be included in the jungle kit, and perhaps every man should be compelled to add a toothbrush, large cake of soap, pair of socks, mosquito repellant, insecticide, and a couple of K-rations before he takes off. They will be a regular part of my jungle kit from now on.

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HEADQUARTERS
462ND BOMBARDMENT GROUP
Office of the Intelligence Officer LWMcD/bhl

APO #220,
29 August 1944.

SUBJECT: Narrative of Ditching B-29 Aircraft Number 42-6263.

TO : Commanding General, XX Bomber Command, APO #493, %P.M., N.Y., N. Y. ATTENTION: A-2, Escape and Evasion Officer.

1. Submitted herewith is the narrative of Combat Crew members experiences in the ditching of B-29 Aircraft #42-6263, on 8 July 1944, while on a cargo flight from Piardoba Army Air Base to the Advanced Base in China.

2. Loading list for the Aircraft on this flight was as follows:

| | | |
|---|---|---|
| Dock O. Waller | Captain | Pilot |
| David F. White | 2nd Lt. | Co-Pilot |
| Walter R. Russell | 1st Lt. | Navigator |
| Edgar E. Hammond | 2nd Lt. | Bombardier |
| Arthur B. Tuttle | 1st Lt. | Flt Engineer |
| Don F. Carter | S/Sgt | Radio |
| Edward L. Swart | S/Sgt | Radar |
| Alden G.Muisjen | T/Sgt | Senior Gunner |
| James M. Lynch | S/Sgt | Right Gunner |
| Francis H. Iles | S/Sgt | Tail Gunner |
| Jennings, | Sgt. | 331st Service Squadron |
| Graffious, W. K. | W/O | 331st Service Squadron |

3. Three (3) crew members lost their lives by drowning. The bodies of Staff Sergeant Francis H. Iles and Staff Sergeant James L. Lynch were recovered. To date nothing has been heard from Staff Sergeant Lenard L. Anderson and it is presumed that he too drowned since fellow crew members report that he was unable to swim.

4. Narratives of individual crew members are as follows:

a. Captain Dock O. Waller, Pilot.

Normal take off was made from Piardoba Army Air Base at 0756 on 8 July 1944, in Aircraft #42-6263, and course for first leg of hump mission begun at 2,000 feet. At 0903 a climb was begun in order to clear the Shillong Hills. The flight plan was to level off at 8,000 feet.



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Just after beginning the climb the right scanner reported black smoke coming from number four engine. Climb was continued with scanner watching number four engine closely and during the climb the smoke decreased in density. During the climb there were heavy gas fumes in the front compartment of the aircraft and investigation showed that the front bomb bay tanks were siphoning. When 7,500' altitude had been reached the right scanner reported that #4 engine was on fire.

I immediately got the course for Piardoba from the Navigator and began turning to it while the Engineer was using the fire extinguishers on the engine. After both extinguishers had been used the engine was reported still on fire by the Engineer, Right Scanner and Co-Pilot. I then ordered bail out of all crew members, this was at 0925. The Co-Pilot, Bombardier and Left Gunner, who was riding as assistant to the Engineer, bailed out of the nose wheel well. The bomb bay doors were opened for the gunners and I believed that all of them went out this way. The tail gunner was, as far as I know at present, riding as right scanner. There were two passengers riding in the gunners compartment and I presumed that they jumped from the bomb bays as well. Just after the third man had jumped out of the nose wheel well the Engineer reported that the fire was out. Bail outs were stopped immediately, at this time only four remained in the aircraft. They were the Radio Operator, Navigator, Engineer, and myself, the pilot.

I continued on course for Piardoba but was losing altitude at approximately 200 or 300 feet per minute while travelling at an airspeed of 43 inches and 2,400 rpm. Two attempts were made to feather the engine but each time the propeller ran away. I did not salvo the bomb bay tanks because I was afraid to risk spilling gas in the bomb bays with the fire on the ship. At 0940 it became apparent that it would not be possible to reach Piardoba so the course for Kurmitola was begun as this was the nearest base. When about thirty miles from Kurmitola and at 1,000 feet altitude it was apparent that I would not be able to reach that base. I informed the remaining crew that I was going to ditch. For the ditching a lake directly on course was chosen. For the ditching the Navigator sat in the Co-Pilot's seat and the Radio Operator sat by the Engineer.

Just before we actually hit the water it was necessary to put the turbos full-on in order to pull over trees between the plane and the lake. A power approach was made with power on until just a second before the actual impact. I made the approach so that the initial contact would be with bull rushes in hopes that this would cushion the aircraft and there would be no bounce. There was no bounce nor any sudden jerk as the aircraft hit, but a decisive slowing up which was not forceful enough to pull anyone from their seat. Neither of the four of us received any injury. We crashed at 1005.

After the aircraft stopped we immediately got out, carrying nothing with us. Since the front lower turret had given way the forward compartment was filling up rapidly and it was impossible to return for anything. Not only was it impossible because of the water but there was also heavy gas fumes. We pried open the life raft doors and inflated both rafts. Taking the Navigator with me I went in to shore, leaving the Engineer and Radio Operator in the other raft to guard the ship which was slowly sinking.







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On the shore we were met by natives who served us tea and food. They produced a student named Mihr Lalsahah who could speak English. He told us that we were at a place called Khana and that he would arrange boat transportation to the nearest railroad. Sergeant Carter, Lieutenant Russell, Lieutenant Tuttle and I walked with the native student to Matkhola, which was approximately twenty minutes from Khana. Here he arranged for a boat which took us to the railroad at Karoid, charging us ten rupees for the trip. I offered the student a gift of money but he refused stating that he was delighted to be of service to American airmen who were helping India. The student also made arrangements with the local police of Pakundia Police Station to guard the aircraft until myself or someone else returned to destroy it.

We arrived at the railroad at Karoid four hours later and proceeded to Kurmitola. Upon arrival there I called AA Bomber Command and gave details of the accident. I was told to await instructions. On the following day at 1100 Major Burns arrived in a B-25 Aircraft and decided to bomb Aircraft #263. Two bombing runs were made and 8 X 500 pound bombs were dropped with unsatisfactory results. Arrangements were made with the Service Group at Kurmitola to send a salvage crew to destroy the aircraft. Later in the day we returned in the B-25 to Piardoba Army Air Base.

b. 2nd Lieutenant David E. White. Co-Pilot.

I bailed out of aircraft #263 through the nose wheel well and saw four other chutes in the air but went into the overcast and lost track of them. I left the overcast several hundred feet from the ground and observed the entire area to be covered with water. I began loosening the chute harness and had unstrapped one leg strap and was undoing the other when I hit the water. I had no difficulty in getting free from the parachute. I undid the jungle kit and it floated to the surface. There was a native boat about one hundred yards away and I called several times for help. When they ignored me I placed the jungle kit under me for support and started to swim. No one else had landed near me. I swam about two hundred yards to a bamboo pole sticking up in the water and hung on to it. I was able to pull myself up the pole and saw more native boats. When I called for help they rowed out to me. At first they seemed reluctant to take me into the boat but I climbed halfway in and held on and then they helped me in. I could see a chute some distance away and by using gestures persuaded them to row to it. We pulled the chute from the water but it was empty and no one was in the water nearby. We searched the area for quite a while and saw another chute. We started to go to it but before we could reach it another native boat had arrived and I saw them pull another man from the water. We then rowed to a small island, no larger than 100 feet long and 40 feet wide, upon which were five native huts. The natives were extremely tall with mongaloid features and wore chin whiskers. They were very friendly and gave me leaf cigarettes. After two hours another boat brought in Lieutenant Hammond and Sergeant Huisjen. I opened my jungle kit and found one compass filled with water and useless, however the second compass functioned after being shaken out. I intimated by gesturing that we wanted to be taken to the west.



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The natives however did not understand. Soon a native from a nearby island arrived who spoke a few words of English. I pointed to the west and made train noises. He shook his head and said, "No" and kept saying "Police Station". He put the three of us in his boat and after two and one-half or three hours we came to a larger island and the village of Tahirpur. Here we were met by some territorial policemen who took us to their headquarters. There were no communication facilities available. The police said that they would get a boat to take us to Sunamganu. Meanwhile the police heard that three other crewmen had been lately picked up on the other side of the lake so we decided to wait until they arrived. At about 1600 Sergeant Swart and Sergeant Jennings and Warrant Officer Graffious arrived. At 1730 we left by boat for Suhamganu. The boat was propelled by long poles and the trip lasted nearly twelve hours. We arrived at 0400 the next morning. Here we were met by a Rice Control Officer and some other Local officers. We sent a wire to Sylhet. At 1300 the following afternoon a C-47 came from Sylet and circled. We stood out in the yard about five yards apart so that they could count us. They dropped a handkerchief secured around a message telling us that a rescue party would come. Shortly after a British Major and Lieutenant came to the building and told us that we could use their motor launch to go to Sylhet. We decided to accept the offer and wired Sylhet to meet us at a ferry landing just above Sylet. We arrived at the ferry at 0300. We waited until 0300 and then crossed the river. Lieutenant Hammond and I started walking to Sylhet and after having gone about five miles we were met by a Military Police Captain and a Sergeant in a Command Car. We returned and picked up the other members of our party. At Sylhet the Intelligence Officer told us that two flat botton gas boats had gone searching for us. I accompanied a search party in a C-47 aircraft to the scene of the ditching and went again the following day. We found nothing. We were then flown to Tuzgon where we were in turn flown to Calcutta. From Calcutta we returned to Piardoba by train - elapsed time from accident was eight days.

c. 2nd Lieutenant Edgar E. Hammond, Bombardier.

I left the plane through the nose wheel door and had no difficulty clearing any obstacles. When I came through the overcast I saw the water and started to unbuckle the chute straps. I easily got free from the chute. There were no boats in sight and I started swimming toward an island about one mile away. After swimming about one-half hour I became exhausted and tried to remove my clothing - succeeded in getting off one shoe. The next thing I remember is being hauled into a boat. When I came around I discovered that I was on an Island. From this point my experiences parallel those of Lieutenant White.

d. 1st Lieutenant Walter R. Russell, Navigator.

I did not parachute. Following the ditching I crawled from the pilots window. I encountered difficulty in releasing the life raft but finally two of us were able to get free. I went ashore with the pilot as related by him.



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c. 1st Lieutenant Arthur B. Tuttle, Flight Engineer.

When we prepared to ditch I fastened my safety belt and held the Radio Operator, Staff Sergeant Carter, so that he would not be thrown about in the crash. On impact with the water the lower forward turret was pushed up into the cabin making the compartment very dangerous. I had removed the engineer's escape hatch just prior to ditching. I climbed out on to the fuselage. The cabin was filling rapidly from the turret rupture and there were strong fuel fumes. The plane settled very slowly. I removed the left life raft and inflated it. There was no equipment in the raft and it was not tied to the aircraft, however the water was calm and it did not float away. I pulled the raft around to the tail gunner's position and found the escape hatch closed. Captain Waller left me to guard the plane. More than one hundred natives had come to the scene, however they made no attempt to board the plane. I made two or three unsuccessful attempts to go back into the aircraft through the submerged hatch. After the aircraft had settled until only the tail fin was visible I got some short boards from the natives and paddled to shore about 600 yards. After making shore Sergeant Carter and I walked to the home of the English speaking student where we joined the others. From this point on my experiences parallel those of Captain Waller.

f. Staff Sergeant Don F. Carter, Radio Operator.

I was with Lieutenant Tuttle throughout the accident. I have nothing to add to his narrative.

g. Staff Sergeant Edward L. Swart, Radar Operator.

When ordered to bail out I left the aircraft from the rear door. When I landed in the water I quickly got free from the parachute. I unfastened the jungle kit and used it as a float. I swam about for approximately forty-five minutes and was then picked up by a native boatman and taken to an island where I found Lieutenant White and the others. From this point on my experiences parallel those of Lieutenant White.

h. Staff Sergeant Aldon G. Hanisjen, Senior Gunner.

When I bailed out I saw four chutes in the air below me however I lost sight of them when they went into the clouds. I fell for about eight minutes and when 200 feet from the water I broke out of the overcast. I could see three chutes in the water, however I did not land near them since a strong current of air swept me far out in the lake just prior to landing in the water. When I saw the water I undid both leg straps hence was quickly free from the chute once I hit the water. I started swimming without trying to remove my clothing but became very weary and succeeded in getting all of my clothes off. I squelched a panicky feeling and swam toward an island, it is estimated that I was in the water for an hour. I alternated swimming and floating and remained in good shape. Finally a native dugout appeared but they seemed afraid to take me into the boat, but when I held on and kept lunging in they aided me.





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I conveyed with gestures that there were others somewhere in the water. We finally saw a parachute and rowed to it and found it to be my own. Since we could see no other chutes we went to the island where I joined Lieutenant White and from that point on my experiences parallel his.

5. Interrogator's notes.

a. During the interrogation crew members made the following suggestions and significant comments.

(1) All natives after overcoming a momentary reluctance were extremely helpful and sympathetic. The boatmen evinced great interest in personal adornments, watches, rings and crash bracelets and it is suggested that crew members be advised to leave all trinkets behind. While Lieutenant Hammond was in an exhausted condition the natives tried to remove his rings. While in the boats the natives inferred that they be given watches and bracelets.

(2) Lieutenant Russell encountered great difficulty in freeing the right life raft and states that he alone could not have released it. The grip is so tiny that it does not permit a firm grip and slips through the fingers. He suggests that a four or five inch grip with a bar be devised. Lieutenant Russell and the pilot also concur in the suggestion that a remote life control release be installed near the pilot or co-pilot seat, enabling them to release the raft as soon as the plane is down. It was fortunate in this case that the plane remained afloat for a considerable time.

(3) Several remarked that they had not known previously that the jungle kit makes an excellent life preserver and is capable of keeping one afloat for a long period.

(4) The pilot, Captain Waller, suggested that the 'ditching' procedure be changed thus:

(a) Eight men sit in the front pressurized compartment ahead of the lower forward turret, on the floor with their backs to the nose of the plane.

(b) Pilot use power-on on all engines on approach and try to as nearly as possible make the contact point a power-on stall. This will allow the pilot to choose the exact moment of contact.

MALCOLM W. MC DIVITT,
1st Lt., Air Corps,
Interrogating Officer.

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HEADQUARTERS 444th BOMBARDMENT GROUP
Office of the Intelligence Officer
APO # 215

22 July 1944

REPORT ON CRASH LANDING OF AIRPLANE 42-6302

This report covers the events leading up to the crash landing on Saturday, 15 July 1944, of airplane 42-6302 of the 678th Bomb Squadron on the return trip from A-3 to B-3. The resume of this report is based on the remarks of Lt. Heise, co-pilot; Lt. Grasson, navigator; and Lt. Gerber, flight engineer, inasmuch as Major Patrick, pilot, and Lt. Norton, bombardier, had not yet returned to the base. However, in the interim both have returned and Major Patrick stated that the report was correct. The experiences of the crew members who bailed out are the statements of the individuals concerned.

The complement of personnel on the plane were as follows:

Major Merrill F. Patrick - pilot
Lt. Arthur Heise - co-pilot
Lt. James V. Grasso - navigator
Lt. Merlin Norton - bombardier
Lt. Carl Gerber - flight engineer
S/Sgt. Richard C. Davis - S. Gunner
S/Sgt. Edward P. Gosich - T. Gunner
S/Sgt. Robert W. Gluck - L. Gunner
Sgt. Donald W. Hoard - R. Gunner (dead)
Sgt. Harold A. McQuinn - Radar Oper.
Sgt. Walter C. Johnston - Radio Oper.

(Because of unfavorable weather the pilot did not locate his home field. When gasoline was almost exhausted) at 1235 IST Major Patrick called the entire crew on the interphone and told them they could either bail out or stick with the ship and crash land.

Four members signified their intention of bailing out, namely Sgts. Gosich (Tail Gunner), Gluck (Left Gunner), and McQuinn (Radar Operator). The aforementioned members bailed out at about 3500 feet to which altitude the plane climbed at a spot 18 miles southeast of coordinates 24°05'N 89° 35'E.

After these members had bailed out, Major Patrick started to look for a spot to crash land. The bomb bay was salvoed



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after hanging up momentarily. The place selected was an inundated rice paddie. As the plane came in to land at 1242 IST, number 3 and 4 engines cut out due to lack of gas. Major Partick applied the throttle to the engines but there was no response. The plane stalled out at 90 mph and made a smooth landing, skidding along for about 150 feet and then veered 20 degrees to the right coming to a full stop.

There was no smoke but mud and other earthen elements filled the air. The flooded paddie was about 10 feet deep due to the monsoons and immediately after the crew members scrambled out on the wings, the plane started to sink. They released the two life rafts externally and got into the boats.

Within 5 minutes there were hundreds of natives in boats around the plane who started to swarm all over it. Major Partick and Lt. Grasso then went over to the boat belonging to the "president" of a local village, and were taken to the town of Bera in order to contact the home field. The natives were very helpful though it is felt that some monetary distribution should be made to them, in case of any future landings in that area.

No contact was made with the crew members who had bailed out due to the terrain and the party passed the night in the local village. The following morning, Sunday 16 July 1944, Major Patrick, Lts. Grasso, Heise, Norton, Gerber, and Sgts. Davis and Johnston went to Bera having made sure that there was a sufficiency of guards around the plane.

They arrived at the latter point at 1500 IST. Major Patrick and Lt. Norton remained at Bera and were to be picked up as soon as they received work as to what to do. At 1700 two enlisted men from the Army Signal Construction Battalion at Ishurdi (24°09'N - 89°04'E) met the crew and took them to the latter camp arriving there at 0300, 17 July 1944.

They were then taken to Calcutta arriving at 1030 IST, 17 July 1944, and were thereafter flown to B-3 arriving at 1800.

The body of Sergeant Hoard has been recovered and is being buried in Calcutta.

Crew Suggestions

That facilities be established at Kharagpur so that "GDM's" could be given by that station.

Suggest that Mae Wests be carried on hump missions due to inundated areas west of the hump.



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Statement by S/Sgt. Edward P. Cosich (Tail Gunner)

When we were given the word to jump - I bailed out through the rear bomb bay at approximately 1235 IST from 3200 feet. I counted 3 slowly and pulled the ripcord. I landed in water and was swept backwards - the water was about shoulder high. I took off my chute and jacket and started to wave the jacket at some natives in boats. After about 30 minutes in the water I was able to get one of the natives to take me into his boat with the promise of "Baksheesh" and indicated that they take me over to where the other 3 members had landed.

They all landed in the river. One of the natives who could speak a little English brought a parachute over and stated that one member had drowned.

When I joined Sgt. McQuinn we stayed around the area where Sgt. Hoard went down. As we landed we heard Sgt. Hoard frantically screaming. We determined that the water was about 15 feet deep. Sgt. Hoard could swim but he evidently drowned.

Sgt. McQuinn and I walked about one half a mile to Saratnagar station of the Bengal-Assam Railroad (Eastern) where we met Sgt. Gluck. We walked down the tracks for about 2 miles to the next station which was Bhangara and boarded a train for Ishurdi.

We contacted Captain Regan, C.O. for the 432nd Signal Construction Battalion (avn) Co. "B" and stayed overnight at that camp. Captain Regan sent out two search parties early Sunday morning, 16 July 1944. At 0700 we got on the Darjeeling Express and arrived in Calcutta where we reported to the Hindustani Building. We came back to B-3 on Monday, 17 July 1944.

Statement by S/Sgt. Robert W. Gluck (Left Gunner)

I jumped and having felt myself turn over twice, pulled my ripcord. As I was about to land I unhitched my leg harness and as I hit the water, I unloosened the shoulder harness. I landed on my back in the river and after swimming for a couple of minutes was able to stand shoulder high in the river. I stood there for about 10 minutes trying to get one on the native boats nearby to help us.

Finally one did and I got in the boat and the native took me to shore. My efforts to get him to take me over to the spot where the other crew members landed were futile. He insisted that I come with him to his local village in





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the immediate vicinity where the whole town turned out. They gave me some tea to drink. Thereafter I went down to the shore to join Sgts. Cosich and McQuinn near the railroad station. Thereafter my experience was the same as Sgt. Cosich.

Statement by Sgt. Harold A. McQuinn (Radar Operator)

I bailed out and pulled the ripcord about 3 seconds after leaving the ship.

I landed in a river on my back. The water was over my head and the seaweed made it impossible to swim. I was in water about twenty minutes - there were canoes near me but they wouldn't help me till I hollered "rupee" - I got into a canoe finally and another boat with the local station master in it came up and asked if I were friendly or enemy.

I showed him my dog tags so he took me in his boat to the spot where Sgts. Cosich and Hoard had landed. My experiences were the same as Sgt. Cosich.

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* Initials: NSB *
* Date: 17 August44 *
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Interrogation Officer: Cooke, H. L. Captain
Squadron: 677 Bombardment Squadron
Group: 444 Bombardment Group
Plane Number: 24420

Crew:

| | | |
|---|---|---|
| | Pilot | Furchner, Fred T Captain O-428615 |
| | Co-Pilot | Hudson, Elwin A 1st Lt O-750992 |
| (Inj) | Navigator | Gaspar, Theodore F 1st Lt O-759548 |
| | Bombardier | Sparrow, Howard G 1st Lt O-673905 |
| | Engineer | Fort, George E 1st Lt O-861299 |
| | Right Gunner | Hellman, Richard B T/Sgt 20138976 |
| (Dead) | C.F.C. | Carl, Robert J S/Sgt 32692389 |
| (Inj) | Tail Gunner | Ward, Andrew F S/Sgt 39092042 |
| (Inj) | Radar Operator | Pfister Willis W Sgt 16156638 |
| | Radio Operator | Kenneson, Howard F T/Sgt 31141805 |

Take Off -- 1001Z
Over Target -- 1943Z
Altitude -- 15,000'
Weather over target -- Undercast 10,000'
Weather Out -- Overcast 14-16,000' Undercast 5-6,000'
Weather Back -- Same. Occasional Thunderheads
Bombing Results -- Bombs were observed to fall beyond the airdrome in the area of the Hi-octane plant.
Anti-Aircraft -- 8 Heavy AA guns were observed in the area of the IP. Flashes on ground were observed, but no bursts in the air (exact location of these guns was not determined)
Target Area -- Automatic Weapon Fire
Moderate
Low
Behind
Left, right and accurate
No heavy AA in target area.
Enemy Aircraft -- Plane observed 1500 yards, level left, bearing single white light, in target area for 2 minutes after bomb run. No interception.
Observations -- Three or four fires, apparently from oil tanks were observed on the bomb run in following positions:
(A) Tank farm NW of A/D
(B) Tank farm E of A/D across river.

The following surface craft and planes were patrolling along the flight path during the return of the B-29s up to 700 miles from China Bay:
(a) 1 CL
(b) 3 DD's
(c) 4 HSL (High Speed Launches)



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(d) 4 Beaufighters
(e) 2 Warwicks (ASR)
(f) 3 PBY's
(g) 4 Walruses
(h) 2 SS were also stationed off the West coast of Sumatra.

In addition to these the following were standing by at various bases in ceylon:
(a) 2 HSL
(b) 5 PBY's
(c) 2 Beaufighters
(d) 4 P-47's
(e) 6 Spitfires

All the planes were under the command of the RAF ASR at China Bay.

The first call from plane 420 was at 1947Z reporting that the PT had been bombed.

The second call was at approximately 0305Z giving the ETA at 0420Z at China Bay.

The third call at 0400Z was an SOS reporting plane about to ditch and giving position as 09°00'N - 83°30'E.

Immediately upon receipt of this message the following surface craft and planes were dispatched (Patrol planes already in the area were advised on the position and ordered to search there)
(a) 2 HSL
(b) 1 Beaufighter
(c) 1 PBY

There are no confirmed reports that the SOS sent at approximately 0530Z by 420 was received by anyone. However, a Liberty ship heading into Madras, 120 miles from the ditching position may have received this call, since this vessel was observed the following morning heading towards the position about 80 miles and 120° off her prescribed course. It is certain that this ship received either the first or second SOS from the Gibson Girl and was homing on them.

The second SOS from the Gibson Girl was heard at approximately 0625Z, by a Warwick about 220 miles South-West from the rafts and by a Beaufighter about 125 miles south of the position. (It was not possible to home on this signal.) Since it was not known that the portable transmitter had a range approaching those distances. RAF ASR operations decided to concentrate its search in the area between these two reporting planes. (a 74 mile stretch)

2 PBY's were dispatched on this mission.

Search meanwhile continued in the first reported position throughout the night by 2 HSL and 1 PBY Hoping to see flares from the Dinghies.

Subsequent information indicated that the search must have came very close to the rafts although none of the survivors reported having heard engines during the night.

The next morning at 0145Z an SOS from the Gibson Girl was picked up by a DD 80 miles South-Southwest of the position which homed on this signal. The same call was received by a PBY (1) 170 miles Southeast





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from the position which was also able to home. Other rescue planes in the vicinity including Beaufighters, Warwicks and B-29 homed on the signal.

The dinghies were actually located by a Warwick ASR at 0440Z and position was established as 09°16'N - 82°43'E.

A B-29 which had been homing on the signal arrived shortly after the Warwick and these two planes circled the position until the rescue was complete.

Two ASL, Two PBY's and 1 DD were directed to this position. The PBY's were unable to land, and rescue was effected by H.M.S. Redoubt at 0745Z.

Notes:

The beaufighter which the crew of 420 reported was the first to locate them, actually did not see the raft. The Pilot of the plane was questioned and he stated that he never saw the raft although he circled overhead at less than 1000' altitude. He was homing on the signal when it suddenly stopped and he circled, trying to pick it up again.

The Warwick, which located the raft, did not see the raft itself but the box kite bearing the antenna. Even after he had spotted the dinghies he lost sight of them twice while circling.

These two instances illustrate the extreme difficulty of finding a raft visually from the air in a rough sea.

Actual position of rescue was 45 miles from Lt Gaspar's position. It was 80 miles North of course and 95 miles from China Bay.

The Warwick reported an oil slick 10 miles Northeast from the dinghie possibly indicating the position of the crash in which case Lt Gaspar's position was approximately 40 miles off.

RAF suggestions:

(1) Flares be attached to the Mae Wests or strapped to the dinghies. Under favorable conditions, these can be seen 25 miles at night.

(2) The tarpaulin be painted with yellow nottallic paint rather than silver.

DITCHING OF 420

After leaving target it was estimated by the engineer that the plane was beating the planned cruise control and had more than adequate gas supply to return to base. (Note: 420 was one of the new B-29s with center wing tanks and navigators astrodome. The deicer boots had been removed.)

There had been no indication of trouble on the flight except sparks from the exhaust of #3 engine--this was noticed after 3 hours of flight and stopped as soon as the plane climbed to altitude to cross the mountains in Sumatra.

At the time the fuel pressure warning system started to operate, it was estimated that there were 690 gallons in the wing tanks, and 350 gallons in the bomb bay tanks, which were not available, since the check valve between the upper and lower bomb bay tanks had stuck closed.

This defect was noticed when fuel was transferred before climbing to 15,000' to clear the mountains. In Sumatra (7 hours out) it was thought







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at the time that the cause might be an air lock and could be remedied after the plane was depressurized. However, on the return flight no means were found to get those 350 gallons from the bomb bays.

Finally the fuel transfer line from the lower bomb bay was taken apart and gas drained into a five gallon can and poured manually into the center wing tanks. This was done only twice (10 gallons), after this no more gas could be drained from the lower bomb bay tanks.

The Engineer checked the amount of gas in the upper tank visually with a flash light, and could see that it was half full, indicating that the check valve had stuck.

The transfer system itself was operative at all times.

At 0340Z fuel pressure on #2 engine began to fall off, fuel was transferred from #3 and the pressure built up again.

About a minute later #3 began to drop and the engineer advised the pilot to descend from 1,400' and to prepare for ditching.

At this time the liquidometer indicated 50-50-75-75 gallons respectively.

The pilot started to descend with all fuel pressures dropping. The Engineer transferred to the outboard engines causing the inboards to stop. At the time of ditching the outboards were sputtering.

The plane ditched not more than five minutes after the first indication of trouble.

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## PREPARATIONS FOR DITCHING

Before the plane left B-10 all possible loose equipment including wheel chocks etc. had been removed.

As soon as the plane was approximately 300 miles from the Sumatra coast on the return flight, the top ring sight, and the armour door leading to the radar room had been removed and secured on the floor of the radar room. It had been planned to hack out the top dome and one crew member got the hatchet for this purpose. However, there was no time for this.

All crew members wore Mae Wests during the entire flight.

All ditching equipment, sustenance kits etc. were stacked near the main entrance.

As soon as the fuel pressure dropped the pilot ordered the Navigator and Bombardier to take their ditching stations.

The radio operator was ordered to send the position. (In fact the Radio Operator had only time to send this report and was unable to clamp the key down in the CW position.)

The IFF was put on emergency.

The Engineer pulled his escape panel inward and threw it on the floor by the bulk head. The Pilot and Co-Pilot opened their escape hatches.

Positions: Pilot---safety belt fastened, in Pilots seat.
Co-Pilot----Safety belt fastened, in Co-Pilots seat.
Engineer---Safety belt fastened, in Engineers seat.
Radio Operator---Behind the Engineer's panel, sitting with his back to the panel, hands clasped behind head and a cushion behind neck (The Radio Operator did not have time to







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reach his normal ditching position.)
Bombardier---Right gunner sitting in CFC compartment with back to pressure bulkhead, hands clasped behind head, supported by jungle kit.
CFC---Sergeant Carl stayed in the left gunner position, his head unsupported. (Killed)
Navigator--In radar room back to partition next to door, his head supported by two cushions. (Cut on head)
Radar Operator---Sitting to left of rear pressure bulkhead and a cushion behind head. (cuts)
Tail Gunner---On opposite side, head similarly supported. (Leg crushed)

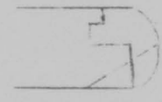
Landing: The sea was fairly rough with 6' waves and white caps. The wind was estimated at 20 knots. Visibility was good.

The Pilot turned the plane into the wind, used full flaps and landed at 100 miles IAS.

The waves were at right angles to the planes course. The plane hit flat on the top of a swell (This first impact was not particularly severe as far as the crew members remember.) It skipped about 80' and then hit full into the next swell. The nose ploughed completely under and the plane stopped in about 2 or 3 seconds.

Everyone on board except the pilot stated that they had no idea that the shock would be nearly as severe as it was.

The front underside of the nose compartment was caved in by the impact roughly along the dotted line.



No other items of equipment broke loose in the front compartment, engineer panel, armour plate, radio equipment etc. Nor was the lower turret forced up through the bottom.

Rear compartment, the impact was very severe in the rear end of the plane.

The front bulkhead remained intact, the bomb bay doors came off.

In the CFC compartment the servo amplifier, amplodynes, the dynamotors and the CFC chair (not the stand) all broke loose and were thrown forward.

The bulkhead leading to the bomb bay caved in and water rushed through forcing a bomb bay tank into the compartment.

The right blister was torn off by the impact, the sight itself remaining in place.

No accurate information is available as to what broke loose in the radar compartment.

The plane crumpled and broke in the middle of the radar compartment. The empennage was twisted at a 45° angle to the wing section on impact and broke off and sunk 3 to 4 minutes after ditching.



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The auxiliary power unit did not break loose.
The camera (K-19) came off it's mount and was thrown forward.
The main entrance door caved in on impact and crushed the leg of the tail gunner who was sitting in his assigned ditching position with his back to the bulkhead.
(Note the three crew members aft of the radar compartment were taken to the hospital at Colombo upon arrival at Trinco and were not available for interrogation.
Therefore it was not possible to find out exactly what happened in the rear of the plane.

Escape--The Pilot stated that the nose compartment filled to 3 feet of water immediately after landing and remained at this level while he was making his escape.
He pulled himself out of the Pilot's escape hatch without difficulty.
The Engineer went through his hatch followed by the radio operator without difficulty. (The Engineer had removed his escape hatch before landing and had thrown it forward against the bulkhead.)
The Radio Operator pulled the life raft release before leaving CFC Compartment.
Sergeant Carl in the left gunner seat was apparently killed on impact.
The right gunner and bombardier left the plane by the right blister around the gun sight. The CFC compartment was rapidly filling with water as they left. They climbed upon the wing after inflating their vests.
The Navigator, who was cut around the head, came forward from the radar room and followed through the right blister.
No information is available as to how the tail gunner and radar operator escaped from the rear section. (The radar operator was thrown about 100' from the plane.
Only one life raft was released by the internal release. The other had been fastened by heavy safety wire and would have been almost impossible to release from the inside. The cover was torn off by the Co-Pilot from the outside, who stated he had to use all his force to do so, and was afraid that he would break the cable before he released the life raft.
The Engineer, Lt Fort noticed the radar operator about 100' from the plane apparently unconscious. He swam over, pulled the cord on Pfister's Mae West and stayed with him until they were picked up by the dingy. While he did this the Engineer collected a sustenance kit, a box of K rations and a 1st Aid Kit, which were floating nearby.
The plane broke in two at the radar compartment about 3 minutes after ditching. The tail sank and the nose went under leaving the fuselage vertical and about ¼ of the trailing edge of the wing above the water.
The plane remained afloat about 10 minutes more.
There was no fire.
The dinghies which were inflated without trouble were boarded. The Gibson Girl which was floating unattached about 25' from the plane, was retrived by the Pilot who swam out and towed it back to the dinghie.





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First Aid--The sea was fairly rough, almost all the crew was seasick. About 1 hour after boarding the dinghie a splint was made for Sgt Ward (the tail gunner) whose leg was thought to be broken.

Sulfa drugs were applied to cuts on other crew members and wounds were bandaged with first aid equipment from the sustenance kit.

Rescue---About 25 carrier based planes were observed flying in formation 15 miles north of the dinghies.

The transmitter kite was launched after 2 unsuccessful attempt and SOS messages were sent for about 5 minutes at 0800Z.

Approximately 1000Z the transmitter was again operated for five minutes. After this the wind died down and the kite fell into the sea. The sea became calmer after sundown and the crew slept through most of the night.

They kept Sgt Ward warm for fear of shock by lying beside him.

No engines were heard during the night.

Next morning it was decided to send SOS signals at 15 minutes to and past the hour, and also when planes were in sight. At approximately 0130Z a PBY was seen to the south, flying west about 25 miles distant.

At approximately 0230Z two B-29's were observed flying east, one 20 miles south of position the second west about 15 miles.

15 minutes later a third B-29 was observed 15 miles south.

The Gibson Girl was operating all this time. At approximately 0345Z a Beaufighter at about 1000' came directly over the dinghy, circled and departed flying east-northeast. The crew presumed they had been seen by this plane.

15 minutes later a Beaufighter, a B-29 and a Warwick came over at about the same time and circled the position.

The Warwick dropped a life raft and sustenance kits.

H.M.S. Redoubt picked up survivors at 0745Z.

They were landed at 1230Z at Trinco, China Bay.

Suggestions--It is imperative that all loose equipment be jettisoned if possible before ditching, particularly from the rear end of the ship.

The ring sight and top blister should be removed.

Water should be provided with the dinghie.

The life raft well should be designed to take all the emergency equipment. It is enough to get oneself out without having to salvage extra equipment from the plane itself.

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HEADQUARTERS 40th BOMBARDMENT GROUP LES/geb
Office of the Intelligence Officer

APO Number 631
30 August 1944

Report of Hump Bail Out

Crew of B-29 Aircraft #425

| | | |
|---|---|---|
| Aircraft Commander | H. R. SULLIVAN | Lt Col |
| Pilot | W. R. SCHILL | Capt |
| Co-Pilot | C. D. HORLACHER | 1st Lt |
| Flight Engineer | L. R. FOWLER | F/O |
| Bombardier | E. T. SHINE | 2nd Lt |
| Navigator | R. E. KUPEC | 2nd Lt |
| Radio Operator | R. G. STARKEY | Sgt |
| Radar Operator | H. S. BRIGGS | Sgt |
| Left Gunner | T. S. KINSLEY | Sgt |
| Right Gunner | D. H. HAHN | Sgt |
| Tail Gunner | T. D. WADDELL | Sgt |
| Central Fire Control | T. S. WALSH | S Sgt |
| Crew Chief | S. E. KELVINGTON | S Sgt |

On 19 August 1944, B-29 aircraft #425 of 40th Bombardment Group took off from B-4 at 1000 IST enroute to A-1 for participation in mission in accordance with F.O. #7, XX Bomber Command. The flight was of a routine nature until approximately 1400 IST, at which time the plane was some 70 miles WSW of Hsichang at an altitude of 21000 feet when #4 engine started throwing oil out of both the top and bottom of the nacelle. Lt Col SULLIVAN was pilot at this time and immediately tried to feather the prop on #4 engine but was unable to do so. Number 4 prop shot up to 3500 rpm and Lt Col SULLIVAN slowed his IAS to 160 in an attempt to bring it down but the relief was only temporary. Flight continued for approximately 13 minutes during which time Lt Col SULLIVAN warned all crew members that it might be necessary to abandon the plane at any moment, and to prepare to bail out if signal was given. At 1405 IST bombs were salvoed to lighten the ship. Number 4 engine continued to grow worse and at approximately 1413 IST started to disentegrate with pieces flying off and striking the ship. Capt SCHILL as Co-Pilot claimed that the terrific strain caused the wing to vibrate to a point where he was afraid it would be torn loose from the ship. By this time the ship was at 18000 feet at a position of approximately (27° 25'n, 101° 55'E). Lt Col SULLIVAN gave orders to abandon ship. Bomb bay tank was salvoed, the CFC released the cabin air pressure, and ship was abandoned as follows:

a. 7 crew members, led by Lt SHINE, with Lt Col SULLIVAN last, experienced no trouble in bailing out through the front wheel hatch. This was accomplished by climbing down in the well as far as possible



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and dropping away feet first.

b. 5 crew members experienced no trouble in bailing out feet first through the rear bomb bay.

c. The tail gunner opened his escape hatch and had no trouble in bailing out. However, it is interesting to note in connection with the tail gunner that sometime between the time the tail gunner was first warned that the ship was in trouble and when he bailed out he had put his head out the escape hatch and the slip stream had blown off his helmet with earphones attached. He was therefore not in communication with the rest of the ship over the interphone system and the first he knew of actual abandonment was when he saw Lt SHINE bailing out. All chutes opened without difficulty, the only complaint being that some crew members were struck sharply across the back of the neck by the cross piece modification on the back of the chute. No trouble was experienced by those who were carrying pistols in shoulder holsters.

The bail out was accomplished over fairly rugged country being over what was described as a gorge with a small stream running along the bottom (See exhibit A). Three crew members landed on the S side of the stream, 9 crew members on the N side and the bombardier some distance off on a high peak. At this point it is interesting to note that Lt SHINE, who was the first to bail out and Lt Col SULLIVAN, who was last, were about 3 miles apart, but did not contact one another for some time as indicated in the following narrative. Most crew members after bailing out could see from 10 to 12 chutes and as a result had a general idea where mostof the party were.

Before taking up the narrative following the landing, it is desired to point out several interesting facts.

a. When bailing out only 5 crew members were wearing their web belts with canteens etc. attached, although all had them in the ship.

b. Three crew members did not have their jungle kits attached at time of bail out, although all had them in the ship.

c. F/O FOWLER, the flight engineer, landed in a tree and was suspended some 20 feet from the ground. However, he did not experience any great amount of difficulty in extricating himself from his chute and getting down.

d. The 13 crew members had landed in what roughly comprised three separate and distinct groups, the first of which was composed of Lt Col SULLIVAN, Capt SCHAAL and Sgt Kinsley on the S side of the stream. The second party was made up of the balance of the crew with the exception of Lt SHINE and were on the N side of the stream. Lt SHINE, who was separated from all other on a high peak is referred to as the third party. As can be noted from exhibit A the entire party was now just a few miles W of the Ya Lungchang River, along a small stream flowing into





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the river from the W.

For the purpose of the narrative following the landing, the writer will endeavor to follow a chronological sequence of events leaving general conclusions for a summation at the end.

19 August 1944

a. When Lt Col SULLIVAN landed S of the small stream he had no sooner hit the ground and recovered from the shock thereof when he heard Chinese shouting in the near vicinity. As subsequent events proved, these turned out to be Christian Lolos, two of whom immediately ran to him and whose manner was entirely friendly. He was unable to converse with them through other than sign language and his "Pointee Talkee" was of no use as they could not read. By means of sign language however, they made him understand that he was to follow them and they took him about one mile east to a small farmhouse. There Lt Col SULLIVAN noticed a picture of Christ hanging on the wall, and immediately concluded that he had fallen into the hands of Christian natives. The natives showed him every consideration, offering food which Lt Col SULLIVAN tactfully declined as it was filthy and unsavory. The usual Chinese curiosity was displayed by one and all concerning his gear which curiosity he endeavored to satisfy in every possible way. In the early evening he was joined by Capt SCHAAL and Sgt Kinsley who had been found by other natives. At about 2200 IST a procession of torch bearers came to the farmhouse and gave Lt Col SULLIVAN a note from a Chinese Catholic Priest, who had a small mission a few miles away. The note requested the party to spend the night at the mission. Due to the lateness of the hour, Lt Col SULLIVAN declined the invitation indicating by indorsement on the note that the party would wait until morning before going to the mission. The party remained at the farm house overnight and left at 0600 IST the following morning in the company of a guide arriving at the mission at approximately 1100 IST.

b. The balance of the crew with the exception of Lt SHINE, the bombardier, had all landed on the N side of the stream and were almost immediately picked up by friendly Lolos. The party gathered on a small knoll and although all efforts at conversation through "Pointee Talkees" were useless -- sign language sufficed. The usual Chinese curiosity was displayed by all natives and at this point it is considered advisable to point out that of all the gear possessed by the men, the things which assumed the greatest value in the eyes of the natives were;

1. The parachute shroud lines.

2. The parachute web harness.

3. The buckles and fittings on the parachutes.

Little if any interest was displayed in the silk or nylon fabric. One of the natives who appeared to be the leader, and who turned out to be a Buddhist Priest, indicated that the party should come with him and led





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them a short distance to a Buddhist Temple where they spent the night. During the night party received the same note of invitation that had been sent to and indorsed by Lt Col SULLIVAN. The natives showed the men every courtesy and consideration and in the morning started with them to the Catholic Mission, arriving there about 1500 IST the following afternoon. On the way to the mission the party met Lt SHINE approaching from the opposite direction.

c. Lt SHINE, the bombardier, had become separated from the rest of the party through having landed on a high and precipitous peak. His immediate attempts to get down were unsuccessful and when darkness came he wisely chose to spend the night on the mountain side rather than chance injury in the darkness. In the morning he managed to find his way down and as related in paragraph (b) hereof joined the main party.

20 August 1944

As indicated in the preceeding day's narrative, all crew members were brought to the mission run by a Chinese Catholic Priest at various times during the day of 20 Aug. The Priest immediately took charge, and as Lt Col SULLIVAN related, seemed to know exactly what the party wanted to do and without urging made all arrangements. The Priest could not speak English other than a few simple words and Lt Col SULLIVAN's attempts to converse with him in French, which he indicated he knew, were unsuccessful. He could, however read and write English, which fact readily solved any problems of conversation.

The Priest proved to be an exceptional host and the entire party were fed and shown every consideration. The Priest advised them that they should spend the day resting and that in the morning he would start them on their way to Te Chang. Food consisted of French fried potatoes, goat, egg noodles, rice and various vegetables, all of which proved reasonably palatable although the preparation and serving thereof left something to be desired. During the day Lt Col SULLIVAN went to the point a few miles N of the mission where the plane had crashed into the mountain side, but there was nothing of value to be reclaimed.

During the day numberous Lolos came to the mission and although not friendly, appeared to tolerate the Priest and his work. They were all very dark, and wore dark turbans and capes. They did not mix with the crew, but talked considerably with the Priest. That night the Priest indicated that party should spend the night in his house. However the house was so filthy that Lt Col SULLIVAN fearing disease, requested that the party be permitted to sleep in the church. At first reluctant, the Priest finally acquiesced and the party spent the night in the back of the small church.

21 August 1944

In the morning the priest had made arrangements for a party to take the crew to Te Chang. While getting ready to leave, the crew noticed





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three B-29's and three C-46's flying overhead and endeavored to signal to them by means of the signaling mirrors in the jungle kits. They reported that one B-29 and one C-46 circled and then proceeded. That their efforts were successful is proven by report of B-29 aircraft #269 at position 27° 40'N, 101° 55'E. The party consisted of 10 coolies or bearers, two guides, two armed guards, three burros and one small horse. Prior to leaving the Priest gave Lt Col SULLIVAN what he called a passport which later proved very useful. Lt Col SULLIVAN wished to reward the priest for his kindness, but he refused to take any money. Finally Lt Col SULLIVAN indicated that he wished to make a donation to the mission, and persuaded the priest to accept 5000 CN for this purpose. The entire party wished to reward the natives who had befriended them, but the priest appeared insulted that they would even consider such a thing necessary. In their own inimitable G.I. way, however, the party managed to reward all the natives with such treasures as pieces of the parachute shroud lines, things from the jungle kits and money.

After having been fed, the party set out at about 1000 IST for Te Chang. Their route as indicated on exhibit A was very circuitous, and when they arrived at the Ya Lungchang River the boatman would not ferry them across until Lt Col SULLIVAN showed him the passport given him by the priest. The river was very swift, but, as indicated on exhibit, by poling far upstream before starting across the boatman was able to transport the entire party in several trips.

The terrain traversed the remainder of the day was very rugged and led the party over an 11000 foot pass. The high altitude quickly exhausted the crew members and excellent use was made of the burros and horse to give the boys a lift.

That night they arrived at the hut of a Lolo Chieftan, who at first was very aloof, and distant. Lt Col SULLIVAN showed him the priest's passport which the chief studied with great interest. Lt Col SULLIVAN was convinced that the chief could not read a word but was merely making "face". Having received what he evidentally considered the proper respect and homage due his position, the chief was quick to unbend and proved very friendly by supplying the party with baked potatoes, meat and other food. The night was spent outside near the chief's hut.

22 August 1944

In the morning the chief again supplied food and prior to leaving Lt Col SULLIVAN made him a present of the machete from his jungle kit which pleased the chief no end. The party proceeded without incident into Te Chang where they were immediately taken to a military camp in the center of the city. They were met by a civilian (a Mr. Lee) who appeared to be a person of considerable importance, but who could not speak English. A Chinese doctor was quickly brought forward to act as interpretor which capacity he filled admirably. The entire party was taken to a Jesuit Mission in the city where they were provided with every confort and served an excellent meal accompanied by a generous supply of Chinese wine which achieved the desired results. The night was spent at the mission.





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23 August 1944

In the morning the party was taken to the military camp for breakfast (ham and eggs) and advised that transportation to take them to Hsichang would arrive later in the day. The party noticed that the entire city was festooned with flags and a holiday spirit prevailed. At noon they attended a banquet given by the elders of the city who made every effort to pay homage to the entire party. A truck arrived after lunch and amidst bursting firecrackers shot off in their honor, the party departed for Hsichang. The truck had been accompanied by some of the personnel of the 28th Service Group now at Hsichang repairing the B-29 which made an emergency landing there some time past. The trip required about 2 1/2 hours and the party spent the night with the 28th Service Group personnel.

24 August 1944

In the morning Lt Col SULLIVAN got in touch with A-1 by means of the radio on a C-46 on the field. A-1 wanted to know if any medical aid was needed and upon being told that the party was all well advised them to stand by and that air transportation would be sent them as soon as possible. Capt SCHAAL in the meantime had met a Major YUNG, who had been a pilot in the Chinese airforce until shot down in combat and who was now on the staff of Gen CHANG, who is in command of the 24th Army stationed in that area. Major YUNG invited the party to lunch with the General the following day, indicating that a refusal to such an invitation would be the source of considerable embarassment to him. The invitation was wisely accepted. The party spent the day resting and sightseeing.

25 August 1944

The primary event of the day was the lunch with Gen CHANG who was most friendly and hospitable. His home, a very pretentious building, is located on a high hill in the NW part of the city. The General has 4 daughters and a son. The eldest daughter spoke excellent English and acted as interpretor for her father. The son, a civilian, was well educated and very talkative. He appeared to be about 30 years of age. The lunch was excellent and augmented by considerable wine. The General displayed a tremendous curiosity and seemed to possess better than a working knowledge of the B-29 project. Among the pointed questions he asked were:

a. How many times had our planes been over Japan?
b. How many times had our planes been over Anshan, Manchuria?
c. Where was our rear Base area?

Since the General appeared to already possess a very considerable knowledge of our operations Lt Col SULLIVAN answered all questions which he did not consider violated security in the light of the General's apparently already well established background concerning the B-29 project. A very pleasant afternoon was spent with Gen CHANG, the party returning to spend the night with the 28th Service Group detachment.





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26 August to 28 August 1944

No events of other than passing interest occurred from 26 August until the party's departure on 28 August. Gen CHANG managed to place Lt Col SULLIVAN in a position of considerable embarassment by indicating that he was most desirous of having Lt Col SULLIVAN arrange to take his daughters by air to Chengtu where they are attending school. When Lt Col SULLIVAN indicated that he did not possess the authority to do this Gen CHANG asked that girls be taken to Kunming to catch a plane for Chengtu. Lt Col SULLIVAN managed to evade this when the plane finally arrived by pointing out to Gen CHANG that the plane only had sufficient gas to take it to Jorhat.

The plane, a C-46, did not arrive until 28 August and brought the party back to B-4 without incident.

General Conclusions

1. When combat crews bail out they must learn to take with them vital material such as jungle kits, web belts with attachments, etc.

2. In the Lolo country the parachute shrouds and harness is of tremendous barter value.

3. Block salt should be included in the jungle kits as it is far more valuable than money.

4. Some type of hat and flashlight should be included in the jungle kit.

5. Party chlorinated all water even though mountain streams and springs were very fast and appeared unpolluted.

6. The chute itself is most important to retain to be used to sleep in and as a mosquito net.

7. The signaling mirror in the jungle kit should be used on every occasion as demonstrated by sighting on 22 August.

8. Chest type chutes for the Navigator, Radio Operator, and Radar Operator, would be better than back type.

9. Entire party was most fortunate in falling into the hospitable hands of the Chinese priest and his Christian converts.

10. The courtesy and hospitality shown the crew by the people of Te Chang was most gratifying. Efforts should be made to indicate to these people that their efforts are appreciated by higher authorities.

11. Capt MULLINS of AGAS is well known, liked and respected in the Te Chang, Hsichang area and has evidently done some excellent ground work.





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12. Gen CHANG seems to possess very considerable knowledge of our B-29 project and appears quite anxious to learn more. He is a great local power and while most hospitable and gracious, crews landing in that area should be careful not to discuss classified information with him.

LOUIS E. SCHERCK
Major, Air Corps
Intelligence Officer

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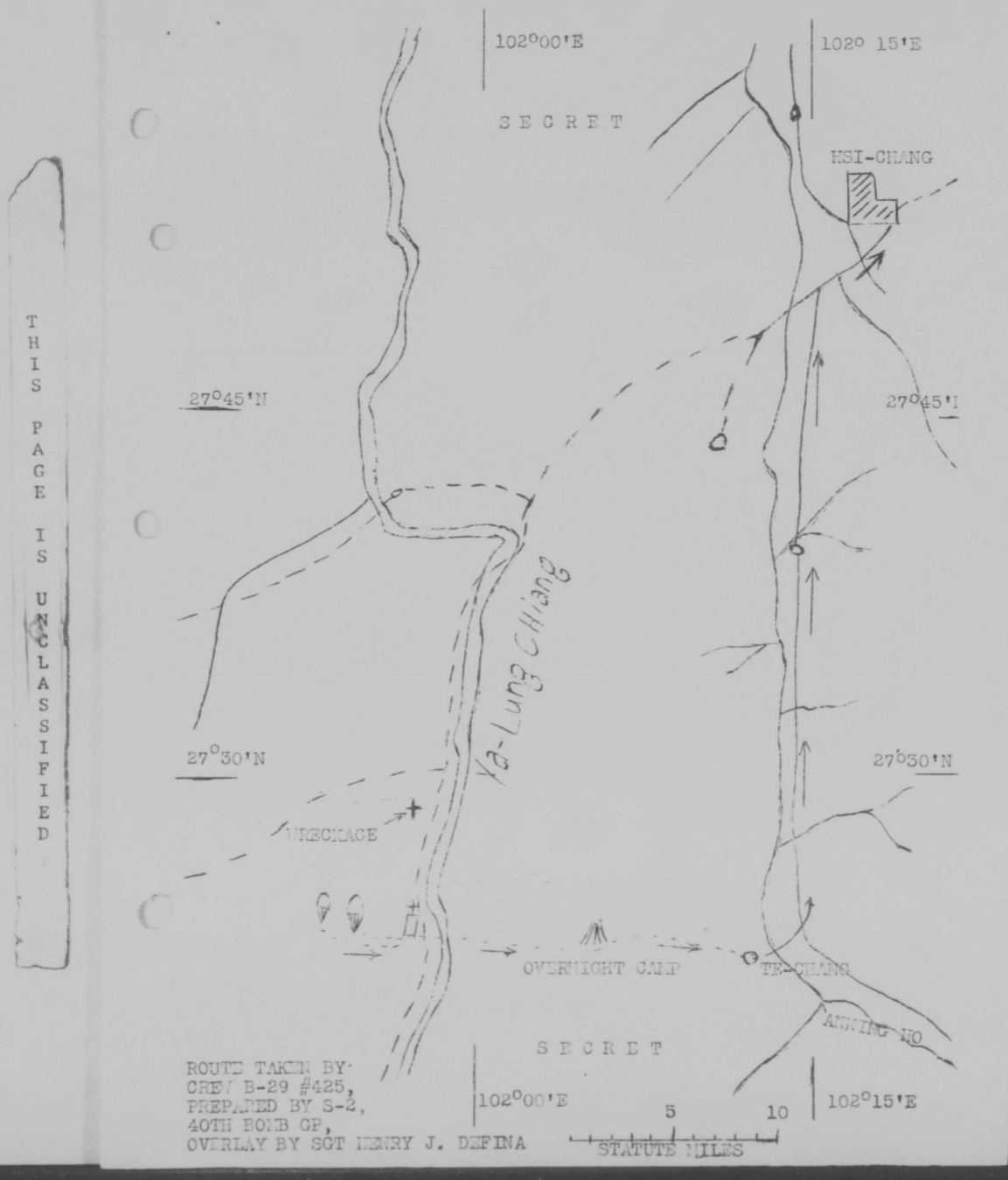


ROUTE TAKEN BY CREW B-29 #425, PREPARED BY S-2, 40TH BOMB GP, OVERLAY BY SGT HENRY J. DEFINA

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*SECRET by Auth: CO, 444th Bomb Group, dated 4 Sept 1944. Initials NSB

679TH BOMBARDMENT SQUADRON
Office of the Intelligence Officer
APO 215

4 September 1944

SUBJECT: Report of Aircraft #42-6320

TO : Commanding General, XX Bomber Command, APO 493.
ATTENTION: A-2

1. A/C #42-6320 joined a 40th Bomb Group formation and, sighting for range only, dropped on the 40th aiming point, observed results were good to excellent. On the Yawata approach #1 engine stuck at 2300 RPM, reducing after bombs were away but sticking at 1400 RPM. Feathering and unfeathering the propeller having no effect, the return trip was made at this power setting. Airspeed was reduced appreciably and the formation pulled away, having slowed down once in answer to a flashed request. At approximately 2300 CST #1 caught fire and was feathered. As the fire could not be extinguished and it was impossible to maintain altitude, the entire crew parachuted safely, landing at (30°50'N - 105°10'E) at 2310 CST, 20 Aug 44.

2. The interrogation reports of the entire crew are attached as enclosures 1 - 12 in the order in which they were taken on arrival at B-3.

/s/ Phillip Sasser,
PHILLIP SASSER,
1st Lt., Air Corps,
Intelligence Officer.

12 Incls:
Incl. 1 - Interr. of Sgt Miller
Incl. 2 - " " Lt. Tallevast
Incl. 3 - " " Lt. Neil
Incl. 4 - " " Capt. Hensinger
Incl. 5 - " " Sgt Nolfo
Incl. 6 - " " Sgt Brown
Incl. 7 - " " Sgt Crandall
Incl. 8 - " " Sgt LaPointe
Incl. 9 - " " Sgt Sanders
Incl. 10 - " " Capt McCarthy
Incl. 11 - " " Sgt Woodzick
Incl. 12 - " " Lt. Pawloski



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INTERROGATION OF S/SGT ROBERT A MILLER, LEFT SIDE GUNNER

About 15 minutes after leaving target, I noticed a thin trail of smoke coming from #1 engine which I reported to Pilot. He said that #1 had dropped to 1400 RPM. This continued until dark when I could see sparks coming out. At approximately eleven o'clock the Pilot told us to get our chutes ready as we were very low on gas. A few minutes later #1 caught on fire, with some flame and many sparks coming out. The whole cowling was white from the heat. When I notified the Pilot of this, #1 was feathered, but #2 was cutting out, so the rear bomb-bay doors were opened and orders were given to bail out. Sgt Woodzick and I jumped through the bombay by stepping out backwards. After counting ten (pretty fast) and turning over 4 times, I pulled the rip cord but as it stuck, both hands were necessary to pull it all the way out. There was very little jar, but it was less than a minute before I saw that I was landing in water. After quite a shock I found myself under water with the jungle pack pulling me down. However my feet hit bottom and I stood up with my head out of the water. Immediatley getting out of the harness, I pulled the chute up on the bank and tried to sleep in the wet parachute.

Someone with a flashlight was on the other side of the river, but when I yelled he ran. I shot my gun three times during the night and heard others fairly nearby.

My escape belt was around my waist, the small kit in my hip pocket (which hurt my hip) and jungle kit attached.

My compass showed that the river headed N-NW, so I walked up the bank and after half an hour met Captain Monsinger, Lt. Tallevast and Sgt Woodzick. We found a village, and after trying out the pointie-talkie on several Chinese men, finally found one who understood and took us by boat to a larger village where two Chinese engineers spoke English. Here we found the others of our crew. Food and water were given and the people were wonderful to us, asking us all about the raid, which they knew of having seen the planes go over in the morning. All but four of us were taken by an ambulance to Sui-Ning, 23 miles away.

We were picked up by a C-46 in the afternoon and taken to A-3 where I was put in the hospital. Though very stiff and sore, the doctors pronounced me O.K. after looking at the six X-Rays of my right knee.

It is suggested that the mosquito repellant be put in a metal container, as the bottle broke when I landed. It is also thought that the escape kit (E-3) should be put in the jungle pack as carrying it down is very dangerous. A flash light could be put in the kit if possible.



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INTERROGATION OF 1ST LT. WILLIAM D. TALLEVAST, RCM OBSERVER

At around 11 o'clock we were told to check our equipment, fasten the jungle packs on, and prepare to abandon ship. Five minutes later I went out the back door after the top gunner and tail gunner, feeling the slip stream carry me back past the plane. On seeing the plane pass over, and the radar operator just coming out of the door, I pulled the rip cord. It only came halfway out, so I pulled much harder and the chute opened. The shoulder straps felt very loose and seemed to want to come off.

When I landed the breath was knocked out of me, and the rocks bruised my hip and legs. The escape kit, which I had brought down under my shirt, bruised my ribs severely, while the jungle pack which was strapped the wrong way up, almost ripped off. The escape belt and gun were around my waist.

While getting out of my harness, the voice of Sgt. Woodzick was heard, and when I answered he came over to me. We fired our guns and heard answering shots. Later we heard Sgt Brown's voice across the river, and Captain Hensinger's farther down, so we walked down to where the Captain was, and we lay down and spent the night.

Next morning I saw some Chinese in a boat but they would pay no attention to us. Later we tried to get a bunch of Chinese who gathered around to read the pointie-talkie, but they could not read, so we walked in the direction from which the people had come. Sgt Miller joined us as we were starting off.

We reached a house where we were given pears and boiling water. Then the people put us aboard a ferry boat, and after making two crossings of the river loaded with Chinese, we went downstream. Sgt Crandall was sighted on a larger boat headed upstream, so he came aboard our boat. A few minutes later we landed and were taken to the headquarters of some Chinese engineers who spoke excellent English. Captain McCarthy, Sgt Sanders, and Sgt Brown were already there and the other crew members arrived a little later. Food and water were offerred after a message had been sent to Sui-Ning airfield of our presence. An ambulance from the field took eight, but four of us went by boat because it was easier traveling.

The mayor, a general, and several city officials met us at the landing with several thousand people shooting off fireworks, shouting and yelling.

At the city hall we were given tea and everybody made a speech. They insisted we go to a restaurant for lunch, and all along the way, the Chinese packed the streets and cheered.

While at lunch medical officers from A-1 came in, examined us and had an ambulance take us to the field where a C-46 was waiting to take us back to A-3.

Suggest that a very small flashlight be put in the jungle pack, and the escape kit also could be carried here.



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INTERROGATION OF CAPTAIN CLAUDE D. HEISINGER, PILOT

On approaching target, #1 engine would not go above 2300 RPM and on leaving target, it would not reduce power settings, finally however, dropping to 1400 RPM and sticking there. This power setting was maintained until when about 75 miles from base the engine caught on fire and was feathered.

Altitude was being lost and the fire in #1 would not go out, so at indicated altitude of 5,000' the crew started jumping. I followed when at 4,000' or approximately 1,500' above the ground. The discipline of the crew in the emergency was excellent.

After two pulls the chute opened without much jar, but almost immediately I hit on a rocky river bank with a severe jolt. Both knees and ankles were bruised and my face cut in two places. My jungle pack, escape belt, and gun were brought down with me.

As the ship had made a 360° turn while the crew was jumping, I landed in the middle of the others. After hearing some shots and shouts I lit a flare and Lt. Tallevast and Sgt Woodzick came up, whereupon we decided to camp there for the night.

The next morning Sgt. Miller arrived and we saw quite a few Chinese, but none would pay much attention to us so we walked upstream for half a mile to where some pears and boiling water were offered.

We were taken by boat (a ferry boat) to where five others were waiting, picking up Sgt Crandall on the way. Here two English speaking Chinese engineers took charge of us, sent people out to help the remaining crew members in, sent Chinese guards out to the crooked up ship, and notified Sui-Ning airfield of our presence.

All of us except the four worst banged up men went to SuiNing by ambulance, the others coming on by boat.

Around 16 o'clock, a plane (C-46) from A-1, landed and took us to A-3.

A flash light should be included in the jungle pack.

The name of the Chinese engineer who helped us so much on the river was Yuan Chih Kang, while 1st Lt. K. W. Chen took care of us at Sui-Ning.

INTERROGATION OF M/SGT FRANK WOLFO, FLIGHT ENGINEER

Being the fourth out of the nose wheel door, I bailed out at the same time as Sgt LaPointe and we talked to each other all the way down, landing without injury close to him. We lit a flare and Sgt. Sanders joined us, and we spent the night here.

Some Chinese, who were watching us when we awakened, led us to Captain McCarthy whose back was very painful. LaPointe staying with him, Sanders and I found Brown, Lt. Neil and Lt. Pawloski whose ankle was sprained. After helping him down the mountain, we all were taken to the headquarters of two Chinese who were building a bridge, and they arranged for transportation to Sui-Ning, four of us going by boat and eight by ambulance.



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After quite a Chinese celebration in which we were all heroes, a plane brought us back to A-3, and later by B-29 to B-3.

The flares in the jungle packs worked wonderfully in getting some of us together, but a flash light would be helpful. My pocket knife had been taken from the jungle kit.

INTERROGATION OF T/SGT GLENN F. BROWN, TAIL GUNNER

I came up to the gunner's compartment when #1 caught on fire, and a few minutes later jumped through the back door immediately after the senior gunner.

The chest pack, which in the hurry of getting out had been put on upside down, came open O.K., without much of a jar. However, when I figured I was 1,000' above the ground, I suddenly hit in the middle of a peanut field with quite a jar, even though the ground was soft.

I fired my gun and lit a flare, and on seeing two others across the river, I made contact with Captain Hensinger and Lt. Tallevast. As the river was between us however, I went back to my chute and went to sleep.

The next morning after trying to make sense with some Chinese without success, I finally found one who could read the pointie-talkie. He took my chute and started leading me upriver. I saw a parachute with a crowd of people around which proved to be Captain McCarthy's, and while I was rolling it up, Sgt Wolfe and Sgt Sanders came up, and we all went to where Capt McCarthy was lying in a hut. Not long afterwards, an intelligent Chinese engineer took us to his house and later we were taken to Sui-Ning by ambulance.

On jumping, I had my jungle pack, escape belt, escape kit, and gun with me. Someone must be looting the jungle packs, for several of them had no pocket knives. A flash light would be most useful enclosed in the pack.

INTERROGATION OF CAPTAIN GEORGE McCARTHY, CO-PILOT

I followed the engineer through the nose wheel, pulled the rip cord when the slip stream pulled me past the plane, saw the plane turn around in a big circle, and hit the ground with quite a jar, falling straight backwards. After getting out of the harness, I found that my back was so painful it was almost impossible to stand up, so I lay there until daylight. During this time I heard several people shouting, some shots fired, and a flare burning.

At daylight I tried walking, but it was almost too painful. However, I did reach a few huts, drank a little hot water, and was trying to make the people understand that I needed help when Sgt Wolfe, Sgt Sanders, and Sgt LaPointe arrived carrying my parachute and Mae West, which they had found. A little later, a Chinese engineer who spoke excellent







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English, came in, having heard we were here. He took complete charge, sending out searching parties to look for the other eight, fixing us a sedan chair for me to be carried in, arranging for some of our money to be given to the Chinese who had helped us, and having me carried to his own house.

When all of the other crew members had arrived, we started for Sui-Ning, four of us going by boat, the others going by ambulance.

Quite a celebration met us at the dock, we were served tea, and then taken to a restaurant to be the guests of the Chinese officials. While still here, officers from A-1 came in, among them a doctor, who we were taken out to the airfield, loaded aboard a C-46 and returned to A-3.

The next morning Sgt Woodzick and I went to Chengtu; had X-Rays taken of my back which proved no broken bones, and after six days in the Chengtu hospital we returned to A-3, and flew back to B-3 by tanker.

INTERROGATION OF 1ST LT CHESTER L. PAWLOSKI, NAVIGATOR

After some rough weather over the China coast I got two celestial fixes and then went back into bad weather. Another fix showed us 14 miles north of course and 150 miles from the field. A few minutes later #1 caught on fire and we were told to bail out. The nose wheel stuck on emergency, but after kicking it and switching the switch back and forth, it lowered and I jumped after Lt. Neil.

As my pilot chute was inside the other one, I was trying to pull the shroud lines to get it out when I hit feet first very solidly, hurting my ankle very much. As I couldn't bear weight on my ankle, I spent the night here.

The next morning I saw that I was on a steep hill with some huts below me. The people below completely ignored me and when I called would approach no closer than 100 yards.

Before long however, Sgt Wolfe and Sgt Sanders found me, and after fetching out Lt. Neil, who was close by, they helped me down the hill by sedan chair to the home of a Chinese engineer.

From here I was taken by ambulance to Sui-Ning, and later by C-46 to A-3 where X-Rays showed that no bones were broken, so after four days in the hospital I returned to B-3.

A flash light would have been of great use to me, and if possible a small one should be put into the jungle kit. The mosquito repellant should be put in a metal container for in most of our cases, the bottle broke, ruining sunglasses, K-rations etc.

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ADVANCED HEADQUARTERS
40th BOMBARDMENT GROUP
Office of the Intelligence Officer
APO #210

27 August 1944

Preliminary Narrative Report: A/C #308
Field Order: #7

A/C #308 departed on mission Seven as the last aircraft to take off in the Second Element. Instrument conditions were encountered soon after take off and aircraft never succeeded in joining its assigned formation.

Enroute to the target they joined a formation of three ships from the 444th Group. Numbers of these ships could not be remembered by the men at the time of this interrogation.

Bombs were dropped on the Primary Target of the 444th Group, New Coking Ovens.

Several hits were made on the ship by both enemy A/C and A.A. Two shells were seen to hit one engine nacelle causing slight damage. At least two hits were sustained in the gunners compartment fatally injuring the CFC gunner Sgt Hause. One projectile - from A.A. or enemy A/C fire undetermined - passed through the Sergeant's lung and another struck his shoulder and hand. Efforts at first aid, giving him oxygen and plasma transfusions, were unsuccessful and he expired sometime along the route back.

Because of battle damage that knocked several of the flight engineers instruments out, a course was plotted to Russia but was never carried out.

Enroute back when over the last row of mountains the ship went into a violent dive. There is a possibility that a control cable, damaged by enemy fire, broke.

The pilot succeeded in righting the ship but apparently feeling this was only temporary called for the crew to bail out. All members of the crew in the forward compartment except the radio operator bailed out through the wheel well door. The radio operator went through the bomb bay to the rear compartment to warn the crew. Shortly thereafter the alarm bell was sounded.

Lt. WILLIAMSON, Flight Engineer, was the last one out of the Forward compartment except for Capt. GRUBAUGH. He was on the ground when he saw the plane hit. Terrain over which the bail out occurred was in



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some of the roughest country on the route. Lt. WILLIAMSON landed on the side of a mountain on which it was almost impossible to stand up. He slid and tumbled down the hillside sustaining many cuts, scratches and bruises and a severe head wound. Upon reaching a rocky muddy surface he felt was the base of the hill, he reclimbed the hill and went down the other side, feeling, that the danger of being picked up by the enemy would not be so great. He stayed where he came down overnight and in the morning walked to a nearby Chinese dwelling where he was aided in reaching the airfield used as an Advanced Base, he believed, by the 3rd Fighter Group. From there he was taken to another field to await the arrival of a C-47 which came that day to pick up the survivors of another aircraft. There he met Sgt. Barnes and Sgt Lunt gunners.

The two gunners were separated after bailing out, however, both landed in much less rugged terrain. After sleeping on the ground that night, they, too, obtained Chinese assistance in getting to the airfield where they met Lt WILLIAMSON and were picked up in the C-47 for return to A-1.

Information such as bombing results, enemy aircraft encountered, etc., is incomplete chiefly because these men were engaged in administering first aid and in maintaining the ship in the air I.E. at the time the ship went into the dive the curtain was down behind the Pilot and Co-Pilot so that Lt. WILLIAMSON could repair the engineers instrument panel.

This missiin report was intentionally delayed hoping that more crew members could be interrogated and a fuller report made since it was known that both Navigator and Bombardier were known to be safe. A supplementary Narrative Mission Report will be made when the other members of the crew arrive.

WILLIAM J. ROONEY
Capt., Air Corps,
Intelligence Officer

A TRUE COPY: /s/ LOUIS E. SCHERCK

LOUIS E. SCHERCK
/snb Major, Air Corps

Reproduced by: Hq. XX Bomber Command.
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HEADQUARTERS 768TH BOMBARDMENT SQUADRON
Office of the Intelligence Officer
APO 220

JM/sbc
29 August 1944

SUBJECT: Report on Interrogation of Crew of B-29 Aircraft Number 42-6332.

TO : Intelligence Officer, 462nd Bombardment Group, APO 220.

1. The following is a report of the interrogation of the crew of B-29 aircraft Number 42-6332 of this Squadron which made a crash landing in Chinese territory on 21 August 1944 following a night mission to Yawata, Japan. Prior to the crash landing eight members of the crew bailed out of the aircraft. Personnel of the crew was as follows:

Captain WILLIAM L. SANFORD, O-420646, Pilot.
1st Lieut. J. H. McCOLLUM, O-808436, Co-pilot;
2nd Lieut. R. C. HOLLY, O-741522, Navigator.
1st Lieut. H. L. FLOWERS, O-739547, Bombardier.
1st Lieut. L. W. KRAKE, O-860942, Flight Engineer.
Sgt. E. F. Morrissey, 32639889, Radar Operator.
S/Sgt. G. C. Thompson, 37141802, Radio Operator.
S/Sgt. J. W. Kelly, 31271407, CFC Operator.
S/Sgt. R. G. Wheeler, 6939767, Left Gunner.
T/Sgt. A. L. Bowers, 16028154, Right Gunner.
T/Sgt. J. B. O'Donnell, 707044, Tail Gunner.

2. Aircraft Number 332 took off from A-5 at 1019Z, 20 August, for Yawata, Japan. After leaving the China coast Captain Sanford began looking for Saishu Island, the last turning point before the I.P. When the E.T.A. for Saishu Island was up there was no sign of the island either visually or on the radar scope so Captain Sanford asked the Navigator for a position and turned on the course for Iki Island, the I.P. The Navigator reported that he thought the aircraft was about 20-30 miles south of course. When the E.T.A. for Iki Island was up Captain Sanford turned on a course of 129° True until the coast of Japan was reached, whereupon he made a 90° turn to the left. After flying north for 10 minutes without sighting Yawata, Captain Sanford asked for a course home, as the E.T.A. for Yawata was up. A left turn was made out over the sea. At 1820Z the aircraft was over land and it was decided to drop bombs on a harbor which had appeared below. Bombs were dropped from 16,500 feet without deviating from course. It was later determined that the bombs had been dropped on the harbor of Fusan, Korea. Soon after "bombs away" the aircraft was over water again on a course of 250° True. In order to conserve gasoline power was reduced as soon as the bombs were dropped. The China coast was reached at 2028Z. The radar equipment became inoperative a few minutes earlier. Soon after crossing the coastline Captain Sanford went on instruments and flew blind



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Report on A/C No. 42-6332 Continued

for approximately three hours. During this time the Radio Operator was not able to pick up anything on his set due to static and interference. When the aircraft finally broke into the clear the Radio Operator contacted A-1 and requested a QDM, which was received about five minutes later. At 2340Z Captain Sanford checked with the Flight Engineer, who reported that there were 1,150 gallons of gasoline remaining in the tanks. enough for three hours' flying time at the power settings which were being used. At 2345Z Number 3 engine began to cut out. Captain Sanford transferred fuel from Number 1 engine and Number 3 started again. Five minutes later Number 2 engine cut out so Captain Sanford called the crew and told them to put on their parachutes and prepare to bail out. The aircraft was at 10,000 feet altitude.

The Radar Operator called Captain Sanford and said he had discovered that his parachute was defective. When he took it off to remove his life vest after reaching the China coast, all the silk had spilled out on the seat behind him. Captain Sanford called the Radar Operator forward and gave him his own parachute. After this had been done all crew members except the Co-pilot and Flight Engineer were sent to the rear of the aircraft. Before going aft the Radio OPerator had called A-1 for a fix but he did not have time to receive it.

Shortly after the crew had gone to the rear of the aircraft the remaining engines cut out and Captain Sanford ordered the eight men of the crew to bail out. This was at 0010Z and the aircraft was at 10,000 feet.

After the crew bailed out Captain Sanford feathered Numbers 2 and 3 engines. Numbers 1 and 4 were still running but were not putting out much power. The aircraft was flying over rough, hilly country and the crew had been unable to spot any airfields where an emergency landing might be made. Captain Sanford noticed a wide river several miles to his left and decided to ditch in it. However, as soon as he banked to the left Number 1 engine cut out so he raised the wing and banked to the right, whereupon Number 4 engine began to cut out. He then righted the aircraft and headed for an open field directly ahead. At this time the wheels and flaps were let down to reduce airspeed and to give Lieutenant McCollum, the Co-pilot, a chance to bail out through the nose wheel door. At this time Number 332 was at about 8,000 feet and was losing 800 feet of altitude per minute. As the field was approached Captain Sanford called for wheels up and the aircraft lost altitude so rapidly that there was not time for Lieutenant McCollum to jump. Whe wheels came up on the battery and were about three-fourths of the way up when the aircraft hit the ground.

Just before landing Captain Sanford noticed a deep ditch with a high embankment on one side running across the middle of the field. He pulled bac. on the stick and the tail section hit the embankment, breaking the fuselage at the CFC position. At the same time the main landing gear hit the ground, broke off, and came up over the trailing edge of the wing. The fuselage then struck the ground and the aircraft skidded approximately 30 feet before coming to a stop. All loose equipment in the fornt compartment flew forward into the bombardier's position but there was no fire after the crash. This was about 0030Z, 21 August. Captain Sanford, Lieutenant McCollum, and Lieutenant Krake



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immediately left the aircraft through the Flight Engineer's escape hatch and stood by for a few minutes to see if there would be any fire. They then climbed back into the aircraft to look it over, and Captain Sanford removed all confidential papers, emergency equipment and rations.

In addition to the break in the fuselage the right wing broke at the Number 3 engine, which came out of its nacelle.* Lieutenant McCollum received a bruised jaw and a cut on his forehead in the landing but there were no other injuries. A temporary shelter was rigged up under the tail.

At the time of the landing no people were observed in the vicinity but within five minutes after Captain Sanford had alighted from the aircraft a large crowd of Chinese farmers had gathered. Captain Sanford attempted to keep the people away from Number 332 but there were so many that it was impossible to keep them at a distance. Two men in the crowd ordered some of the people to bring the scattered parts of wreckage up to the aircraft, which they did. Captain Sanford used his Pointie-Talkie with these two men and they apparently sent word to the nearest village, because at about 0700Z a Chinese magistrate arrived with a group of armed guards, who seemed to be either local police or soldiers of the Chinese Provisional Army. The magistrate gave Captain Sanford and the other Officers sandwiches, eggs, and boiled water and said he had received word that five of the men who had bailed out had been picked up and were safe.

The magistrate was from the town of Yochih, Szechwan Province, 30° 33'N - 106° 25'E. Aircraft Number 332 landed about seven miles southwest of this town. The magistrate said he would see that the members of the crew who had bailed out were brought to Yochih as soon as possible. He then left, leaving the armed guards to help watch the aircraft. The guards kept the farmers away but were so curious themselves that Captain Sanford, Lieutenant Krake and Lieutenant McCollum had to take turns all night guarding the plane to keep the guards out. The three Officers remained with Number 332 all night. About 2100Z the next morning a messenger arrived from Yochih and told Captain Sanford that all of the eight men who bailed out had been picked up and were together in the city of Kwang-an, about 10 miles away.

At 0200Z, 22 August, Captain Barry, an American Army doctor who had been sent out from A-1 by plane as soon as Number 332 was reported down, arrived by sedan chair from Yochih. Captain Barry and one enlisted man had been flown to Namchung, 30° 44'N - 106° 06'E, the day before from A-1 and had come by truck from Namchung, a distance of about 35 miles. Captain Barry told Captain Sanford that he would take him to Yochih to wait for the rest of his crew before proceding to Namchung.

Leaving Lieutenant Krake to guard the aircraft, Captain Sanford and Lieutenant McCollum went into Yochih by sedan chair and were taken to the schoolhouse, where the magistrate was waiting with the local town officials.

* See attached photos.







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Report on A/C No. 42-6332 continued

The men were given something to eat and in about 15 minutes a truck arrived with the eight men who had bailed out. This was at about 0500Z.

3. The eight crew members of Number 332 who bailed out had been picked up by the Chinese and brought together at the home of the magistrate in the village of Sunchue-ho, on the Ku Ho river, Szechwan Province, within one and one-half hours after leaving the aircraft. These eight men were Lieutenants Flowers and Holly and Sergeants O'Donnell, Bowers, Wheeler, Thompson, Kelly and Morrissey. Lieutenant Flowers indicated by using his Pointie-Talkie that he wanted to be taken to a telephone. The magistrate, in turn, used the Pointie-Talkie to find out what sort of food the men wanted and in response to their request for fruit, produced some pears, tea, and warm water for washing. At that time an interpreter, a student at Kunming University, arrived. The interpreter got in touch with the Governor of the district by telephone who ordered that the crew members be brought to him as soon as possible. In the meantime, a large crowd of Chinese had gathered outside the magistrate's house in order to see the Americans and ask them for souveneirs, but guards provided by the magistrate dispersed the crowd. After showing the magistrate their parachutes and personal equipment the eight men were taken to a river at the edge of the village by the interpreter, where they got into a small river boat. The magistrate followed them to the boat, presenting them with a large quantity of boiled eggs and filling their canteens with boiled water. In return the men gave the magistrate a pocketknife and several packages of cigarettes. With the interpreter and boatman, the men started down the river and in about four and one-half hours reached a small village at the foot of a hill, on top of which was a good-sized city. This was at about 0640Z. The men left the boat at the village and were met by two representatives of the District Governor, who had a large number of sedan chairs and bearers with them. The entire party was taken up the hill to the city in the sedan chairs to the home of the Governor. The Governor was Mr. Frank C. Guan and was apparently in charge of a large number of districts or counties in eastern Szechwan Province. He spoke excellent English and informed the crew that they were in the city of Kwang-an, 30° 30'N - 106° 37' E, on the Ku Ho River. He asked them if their aircraft had the number "26332" on the tail. Upon receiving an affirmative answer, he stated that the aircraft had come down about 30 miles away in another district and that two of the men who had remained in the aircraft were all right but that the third man was injured. Mr. Guan had seen the men bail out of Number 332 that morning and had notified three of his districts by telephone that he wanted all of the men brought to him safely as soon as possible. He had also notified Chengtu of the landing and told the crew that three jeeps were being sent out from Chengtu to pick them up. One jeep, with a doctor, was to go to Yochih, where the landing occurred, while the other two were to come directly to Kwang-an for the crew.

During the entire conversation Mr. Guan referred to Number 332 as a "B-28." He presented the crew with American cigarettes, hot tea, and apples, after which they were taken upstairs to bathe and rest. Later they were given a 13-course banquet, where they were introduced to several of the city officials. Following the banquet a Chinese doctor arrived to examine Sergeant O'Donnell,







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who had injured his knee and his back in bailing out. Throughout the evening various officials and merchants called at the Governor's house to meet the Americans. Several Chinese newspapermen called but the Governor refused to permit them to interview any of the crew. At dusk the city was "buzzed" by a C-45, which was a rescue plane sent out from A--1. This plane later landed at Namchung and dropped off Captain Barry and one enlisted man who had originally intended to come by jeep. Before retiring the crew was informed by the Governor that a banquet and celebration had been planned for them the next morning at which they would be presented to the people of the city. Every consideration was shown the crew by the Governor. Each man had his own bed, razor, and toothbrush, and incense was burned during the night to keep away mosquitoes.

The following morning, 22 August, the crew was awakened early and served an American-style breakfast, which the Governor said had been prepared by his wife since he realized that the American Army had certain standards of diet and preparation for its men. The Governor was determined that the crew should be given the best of everything available. After breakfast the Chinese doctor returned to examine Sergeant O'Donnell again. At 0200Z a Chinese truck brought an American enlisted man, Corporal Terry, to the Governor's house. This man had landed in the C-45 at Namchung the night before and had been sent to pick up the crew while Capatin Barry went on to Yochih to locate Captain Sanford. Lieutenant Flowers told the Governor that he thought the crew should return immediately with Corporal Terry, but the Governor refused to let them leave, stating that they would have to put in an appearance at the banquet since the entire city was expecting to see them.

The Governor dressed in a military uniform and the entire party walked through the city to a theatre. Large crowds of cheering people lined all the streets through which the crew passed and many silk banners welcoming the "American Air Heroes" to Kweng-an were hung from the buildings. The theatre was packed with cheering people and the crew was taken to the stage, where they were seated with the Governor and a number of other officials. The Governor made a good-will speech in Chinese, then interpreted for the crew, after which Lieutenant Flowers was asked to make a short speech. The Governor told him to say only that the crew had bombed Japan the day before. The speech was interpreted to the audience, after which each member of the crew was presented with Chinese cigarettes and silk banners inscribed in Chinese and English, with various slogans and words of appreciation to the Americans. Two large baskets of flowers were presented to the crew and tea was served on the stage, during which time a large number of officials, merchants and business men came up and were presented to the crew. Several more speeches followed, after which the theatre was cleared and a full-course banquet served. During the banquet a play was presented on the stage. Finally at about 0330Z the crew was allowed to leave the theatre and were taken to a Chinese truck, where Corporal Terry was waiting with the interpreter who had come down the river with

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the crew the day before. The truck then took the men to Yochih, where they met Captain Sanford and Lieutenant McCollum at about 0600Z.

4. As soon as the remainder of his crew arrived at Yochih, Captain Sanford sent Sergeant Bowers and Sergeant Wheeler out to Number 332 to help Lieutenant Krake guard the aircraft. The crew was then given another banquet after which they watched a parade and fireworks exhibition presented in their honor. At this time Captain Sanford was presented with a basket of pears, a basket of 200 eggs, and a letter of appreciation from the citizens of Yochih, while the other members of the crew received more silk flags and banners.

During the morning the Chinese magistrate of Yochih had some photographs taken of Number 332. These were developed during the afternoon and as soon as Captain Sanford received them the entire crew, Captain Barry and Corporal Terry left by truck for Namchung. This was 0700Z. Just before dark the truck broke down on a mountain road near a small village and could not be repaired. The men went into the village, where Captain Barry and Corporal Terry secured sedan chairs to take them to Namchung. The crew of Number 332 had some of their eggs boiled in the village and returned to the truck to spend the night.

At 0030Z the following morning, 23 August, another truck loaded with bales of paper and 10 people came along the road from Kwang-an and agreed to take the crew to Namchung. They unloaded their truck and squeezed the crew in with the passengers. The Chinese driving the truck refused payment. All negotiations with them had to be made with the aid of Pointie-Talkies. This second truck got within two miles of Namchung, at which point it had a flat tire. This was repaired but there was another flat within a half-mile so Captain Sanford and the crew secured some sedan chairs at a nearby village and went on into Namchung, arriving about 0300Z. Captain Barry had reached Namchung earlier in the morning and had made arrangements for the arrival of the crew. They were met by the magistrate of the town and several city officials, who took them to a shop for tea, then to the second floor of the bank building for an official welcome and banquet. The banquet was held at about 0800Z and was attended by all the city officials and business men, who made speeches and presented the crew with more banners and souvenirs. Captain Sanford was asked to make a short speech which was interpreted for the guests. Following the banquet the crew was taken to the quarters of a Lieutenant General of the Chinese Army for tea, after which they went to a hotel and were given a chance to bathe and rest. At 1200Z the magistrate returned to the hotel and tea was served, after which the crew was taken to a theatre where a play was in progr[illegible]. The magistrate interpreted the play, made a short speech, and asked Captain S[illegible]ford to do the same. After the play was resumed Captain Sanford asked the magistrate to take the crew back to the hotel, but the latter insisted on taking them back to the bank building for another banquet. This was refused, and after stopping at a shop for tea with some officials, the crew was returned to the hotel.

Early the following morning, 24 August, the crew was taken back to the bank building for a breakfast, to which a full General of the Chinese Army







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had been invited. After the breakfast the crew and the General got into a Chinese truck and were taken to Sui-ning, 45 miles southwest, where they were to be picked up by a C-47. They arrived at Sui-ning at 0430Z and were taken to the airfield. The city magistrate wanted to give a reception and a banquet for the crew but Captain Sanford refused. Shortly after their arrival at Sui-ning a C-47 arrived and flew the crew back to A-1.

5. The following are individual experiences of crew members who bailed out, from the time they jumped until they were all brought together. 1)

a) T/SGT. J.B. O'DONNELL, Tail Gunner: "I was the first man to bail out. When the order was given I opened the rear exit door and threw out all loose heavy equipment, such as flak vest, etc., which had been passed back to me by the men waiting in line to jump. I tried to go out head first from a standing position but the wind pushed me back in, so I crouched and rolled out. I jumped out into the undercast and did not pull the ripcord until I had come into the clear. My free fall lasted about 7 - 9 seconds and by the time I pulled the ripcord I had slowed down and had stopped tumbling. My parachute opened easily and I landed in the corner of a rice paddy very close to a house. The wind almost carried me into the side of the building before I hit the gound. I hit the embankment at the edge of the paddy and wrenched my back and knee. I lay on the ground for several minutes trying to find out how badly I was injured. When I landed there were no people in sight but in a few minutes Chinese farmers began to come out of the nearby paddies and soon a large crowd had collected. I got to my feet, took off my parachute and pistol and got out my blood chit and Pointie-Talkie. Just then I heard three shots from behind a hill which was about one-half mile away. I reached for my pistol on the ground to fire an answering shot, but this movement frightened the crowd and they all began to run away. I left my pistol on the ground and shouted several times. In a few minutes Sergeant Bowers, who had followed me out of the aircraft, came around the base of the hill and joined me. By this time the crowd had gathered again so we showed them our blood chits and offered them cigarettes. Using our Pointie-Talkies we indicated that we wanted to be taken to the nearest Chinese magistrate. At this time two rough-looking farmers armed with Lugers came up and dispersed the crowd. These men seemed very angry and acted as if they intended to shoot us. They cocked their Lugers and kept them pointed at us, refusing to look at our blood chits or Pointie-Talkies. Sergeant Bowers began talking fast, indicating that we were Americans. Finally the crowd gathered again and two or three farmers convinced the armed men that we should be taken to a village instead of being shot. Other farmers meanwhile had brought some large wicker baskets, into which they put all our equipment. The armed men seemed satisfied, so the entire crowd started to lead

1) Two of the men who jumped, Sergeants Bowers and Wheeler, have not yet returned to this base from China.



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us off over the rice paddies. We walked for about two miles over several hills and through paddies, finally arriving at a small cluster of huts. Several of the men in the crowd opened a small general store and gave us some water. The leaders of the crowd were very considerate and would not allow us to drink too much water, indicating that it would be bad for us. About this time another large crowd came up, bringing Sergeant Wheeler, who had been the third man to bail out. Several of the farmers were showing great interest in our parachutes so we began to cut them up and pass out pieces of the silk to the crowd. After this was done the men who had given us the water started to lead us away. After a short walk we came to a walled town at the foot of a hill. We were taken into the town and to the house of the mayor or magistrate, who immediately gave us tea. In about 10 minutes a crowd of people arrived at the house, bringing the other five men who had abiled out. We found out that we were in the village of Sunchueho, on the Ku Ho River."

b) SGT. E. F. MORRISSEY, Radar Operator: "I was the fourth man to bail out and followed Sergeant Wheeler. I had no trouble getting out of the aircraft and pulled my ripcord as soon as I was sure that I was clear of the plane. My parachute opened easily and I could see that I was going to land in or near a rice paddy. As I neared the ground I saw a number of people running into the rice paddies and into some houses. I landed on the edge of a paddy about 50 yards from a house and immediately got up, took off my parachute, and began to yell, 'Ding Hao.' Finally a Chinese came out of the paddy where he had apparently been hiding. He appeared to be frightened so I gave him some matches. In a few minutes a crowd of 15 - 20 people had gathered and I indicated that I was an American and wanted to be taken to an American camp. The people motioned for me to follow them and started up over a hill. When we got to the top of the hill I saw a large crowd of people in a field below and then noticed Sergeant Kelly in the midst of the crowd. The people took Kelly and I to a farmhouse and brought us some warm water to wash. As we were washing a group of Chinese came up, bringing Lieutenant Flowers. All three of us began to use out Pointie-Talkies trying to show the Chinese that we wanted to be taken to a telephone, but we did not have much luck. In a few minutes the crowd began to lead us cross-country again and after we had gone about one-quarter mile we me a group of Chinese who had Lieutenant Holly with them. The four of us then followed a very large crowd of Chinese over a couple of hills and we came to a village on a river. As we approached the village a group of Chinese came up with Sergeant Thompson. We then entered the village and were taken to a house where we found O'Donnell, Bowers and Wheeler."





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c) S/SGT. J.W. KELLY, C.F.C. Operator: "I bailed out after Sergeant Morrissey. The soles of my shoes were loose and caught on the door, so I was unable to get out on the first try. I came back into the plane and then rolled out head first, which caused me to tumble in the air. I counted three and pulled the ripcord. The 'chute opened easily. I landed in a rice paddy on the opposite side of a hill from where Sergeant Morrissey landed. I took my 'chute off and noticed that I had landed near a house. There were several Chinese on the porch of the house and they seemed reluctant to come over to me. I didn't want to approach any people while alone so I started to walk around the base of the hill, as I knew Morrissey was somewhere on the other side. I came upon a Chinese farmer working in a paddy and said, 'Ding Hao,' but he apparently did not know what I meant. Several other men began to come down off the hillside so I waited for them. When they gathered around me I reached into my pockets for some cigarettes but the men apparently thought I was reaching for a gun as they started to run away. I held the cigarettes up so they could see what they were and the men came back. Soon a large crowd had gathered. I pulled out my Pointie-Talkie and a man dressed in western-type clothes stepped up and read both the Pointie-Talkie and my blood chit. At this time a group of people came down the hill with Sergeant Morrissey."

d) LIEUT. H. L. FLOWERS, Bombardier: "I followed Sergeant Kelly out of the plane. I had to force myself out the door due to the slipstream. After counting three I pulled the ripcord and the 'chute opened without any trouble. As I approached the ground I saw that I was going to land on the peak of a hill, so I unfastened my chest strap and attempted to steer the 'chute. I drifted away from the peak and landed in a rice paddy at the edge of a river. There were two naked women and one naked man working in the paddy. They came up within about 10 feet of me while I was sitting on the edge of the paddy examining my ankle, which I had twisted slightly. The man would not come close to me but motioned that I should follow him. We went up a hill, on top of which a group of 15 - 20 people had gathered. I attempted to use my Pointie-Talkie but no one could understand it. Finally the people started off to the east, indicating that I should follow them. I thought I should be going west but finally followed the people and in a few minutes came to a group of houses where I found Sergeant Morrissey."

e) LIEUT. R. C. HOLLY, Navigator: "I courched and rolled out the door of the plane. After tumbling a few times I pulled the ripcord. About 100 feet from the ground I bent my knees to absorb the shock of landing. I landed on a small shelf half way up a mountain side, about five feet from a grass house. A Chinese woman came out of the house but ran away as soon as I said, 'Ding Hao,' to



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Report on A/C No. 42-6332 Continued

her. I noticed a group of about 15 women and children on the crest of the hill above me and I beckoned to them. A child ran down the hill to me and carried my 'chute back up to the top. I followed and when at the top of the hill sat down in a straw stack to rest. Two armed men came up and seemed friendly, so I used my Pointie-Talkie to tell them I wanted to be taken to a telephone. They appeared to understand the Pointie-Talkie and were very much interested in it. One of the men wanted to trade his pistol for my 'chute. I refused and finally the men led me down the hillside to some houses, where I met the rest of the men who had jumped."

f) S/SGT.G C.THOMPSON, Radio Operator: "I was the last man to leave the plane. I had no trouble getting out and no difficulty opening my 'chute. I landed on the side of a hill and slid some distance to the bottom, which tangled me up in my 'chute. When I finally got untangled I saw a house about 200 yards away and started to go over to it. There were two women on the porch who looked unfriendly and began to yell, 'Boo Hao,' so I walked away from the house. I ran into two small children who seemed friendly, so I stopped. Immediately a number of people came up and stood around me. I had a cut on my arm which I showed to the two children. One of the children ran back for my parachute and the other led me on to a farmhouse where there were some men. These men brought out some oil for my arm. I showed them my blood chit, which they seemed to understand, so I kept saying, 'Chengtu.' In a few minutes I was given some soup and rice. A man arrived with my parachute and the whole crowd then led me to the village where the rest of the crew were."

S/ James McNab
T/ JAMES MCNAB,
Captain, Air Corps,
Intelligence Officer.

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Date 9 Sept. 44

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K 73160 20th AF 2nd Auction 31 Aug '44

In reply refer to
Initials and No.
Op-16-V-E-CB/bjm

Serial: 134

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D. C.

SECRET

MEMORANDUM

AUG 31 1944

From: Air Intelligence Group
To: Addressees designated on attached distribution list.

SUBJECT: Report of Naval Air Combat Intelligence Officer on XX BC B-29 attack on Showa Steel Works, Anshan, Manchuria, 29 July 1944.

X Manchuria 9930

The field order issued July 18, 1944 called for full availability attack on July 29th on the Showa Steel Works; secondary target -- Chinwangtao port facilities and shipping; tertiary target -- Taku port facilities and shipping; last resort target -- Chenghsien (Chengchow) railroad yards. The route out was base area 32-25'N;111-29'E: 37-32'N;118-55'E: 40-25'N;121-00'E: 41-01'N;121-48'E(P#1): 40-33'N;122-14'E(P#2) - target. The axis of attack was 85 mag. (visual), 90 mag. (radar); the aiming point was assigned so that the center of impact was on the middle coke oven.

The method of bombing assigned was by flights of four (4) aircraft from 25,000 ft. - if overcast, visual bombing from an altitude not more than 2,000 ft, under the overcast, but in no case below 15,000 ft. Enroute target formations reached an altitude of 15,000 ft. or 500 feet under the overcast but in no case under 10,000 ft. before crossing over enemy held territory. Aircraft failing to join a formation of at least three planes before penetrating enemy territory were instructed to join a formation from not less than 25,000 ft. Over the target the lead plane had to have its radar operative.

The bomb load was eight (8) GP 500 lb. AN-M-64 (Composition B) per A/C fused .1 second nose and .025 second tail. Intervalometer settings were 50 ft. and 300 ft.

One photo B-29 was dispatched to cover Taku, Chinwangtao, Anshan, Pensihu, Dairen, and Hulutao; this A/C was instructed to photograph at 30,000 ft. and rejoin formations enroute to base. Cameras were carried in all aircraft for photos over the target.

Planes began leaving the rear area on D-4 day staging into the China base area. On D-1 day the total tactical aircraft ready for the mission was 96 out of 108 arriving in the forward area.

Take-offs began on July 28th at 2215 Z with the last A/C being airborne at 23162. The first A/C was over the target at 0405 Z on the 29th of July. Due to the heavy rain fall on Kwanghan take-offs were postponed until 0317--0410 Z with the first bomb on the target at 0657 Z at Taku; because of late take-off the 444th group bombed the tertiary target Taku thus assuring a daylight landing.

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The weather was forecast good and turned out to be excellent over the target. All planes were able to use visual bombing with bombs released by sight for the first time - all previous missions required radar. Strict radio silence was maintained except for "Lolly" message transmitted by lead aircraft of formation on "bombs away".

Radar counter measures (RCM) were set up as follows: Ten aircraft to search 140-300 mag north of latitude 33 degrees north; six aircraft to search 300-1000mag; coverage to determine enemy radar frequencies, PRF, pulse length, latitude and longitude (location of installation). Special attention was given the 150 mag and 175-220 range.

Bomb damage assessment as confirmed by photograph reveals the primary target well covered, not only the coke ovens (aiming point) but also the by-products plant and surrounding installations. Two blast furnaces, concentrating plants #1 and #2 and chemical and metallurgical laboratories received direct hits. Near misses were registered on the gas cleaning plant for #4 blast furnace and the furnace itself, on #2 furnace, and on the coke by-products plant. In short, the vital target area received many direct hits and the target area in general received good to excellent coverage.

No aircraft bombed the secondary target.

The tertiary target (Taku-Tangku dock area) received five direct hits on the wharf area with blast damage to two large godowns, and one direct hit on a 150/200 ft. merchant vessel; at least ten bombs in the business residential area just northeast of the target; eight to ten bomb burst visible in Yung Le Alkali Plant with destruction of three large shed-type buildings and several smaller buildings. Several direct hits on the marshalling yard just east of the target and on railway sidings nearby. The photos show much new construction approximately tripling the wharf and loading facilities. Incomplete photo coverage shows approximately 25 collier-type vessels 150/200 feet and one AK 250/300 feet in length.

Photo coverage of Chenghsien, the last resort target was of poor quality, revealing no apparent damage. Crews, however, report good bombing results over the railroad and marshalling area.

During this second B-29 daylight mission enemy aircraft were encountered with the following claims resulting: two (2) enemy fighters (Oscar II's) probably destroyed and three (3) damaged. The central gunnery control mechanisms got their first real test and results were satisfactory considering the small number (5-7) of enemy aircraft attacking our aircraft and the enemy's uninspired, lackadaisical attacks, revealing their unwillingness to engage the B-29 formation at close quarters. Enemy fighters were encountered only on return enroute to home base over occupied China. No enemy aircraft were seen over the targets.



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Enemy A/A varied from weak to moderate over the primary target with wide error in both altitude and azimuth. There was no A/A encountered over the Taku-Tangku area while Chenghsien produced only meagre and inaccurate fire.

The weather details over the targets were as follows: Primary target, CAVU (Ceiling and visibility unlimited), with wind 280 degrees at 18 KTS at 0357 Z to 0452 Z gradually building up to 3/10 at 12,500 feet after 0500 Z; over Chenghsien, CAVU at 0451 Z to 0632.

The Japanese air raid warning net was apparently unable to cope with the VLR (B-29) raids. Although the course to the target is predominately over enemy-held territory, the Japs have been unable to pick up the targets with any accuracy at all. The only enemy counter-measures are restricted to fighter interceptions on return course and A/A while over the target. The first planes over Suchen received no A/A at all - the attack evidently being a complete surprise.

General Comments

This daylight mission was the first in which formation flying was attempted and successfully achieved. An anticipated 11% efficiency loss for all except the lead plane in a four plane formation makes this type of flying very expensive; however, the defensive advantages, together with a concentrated bombing pattern, justifies formation flying. Unfortunately the meagre enemy fighter opposition did not thoroughly test the defensive features but the excellent results gained from formation flying pattern bombing compensated for any efficiency loss. The aircraft performance over this 2705 mile route held up satisfactorily; all but two aircraft returned safely. One plane was last heard from while being attacked by five enemy fighters near the LRT (Last Escort Target) while the other aircraft is completely unaccounted for - no word from the time of take-off. One other aircraft shortly after take-off tried to make an emergency landing. The landing gear failed to come down, one engine conked out, and the plane crashed five miles from the strip. Except for these three aircraft all functioned satisfactorily.

The Navy contribution to the mission consisted in providing target information on the Secondary Target and Tertiary Target. Based on Navy target data the "bombing of Taku" actually resulted in the bombing of Tangku which is the more important target in this area. The Navy relayed air raid warning information over the Jap targets to Nanching. Advanced weather forecasts enroute to the target were also sent to the 10th Weather Headquarters for B-29 use. When the last word was received on the B-29 which was forced down by enemy aircraft attack, the Navy station nearby was alerted and an investigation (search) party was sent to rescue the crew and demolish secret plane equipment. Also upon Navy request Hulutao Harbor was photographed in view of prospective mining operations there. Because of the mission being flown for the most part over land there was no need for the Navy Air-Sea Rescue Service which has now been set up.

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From every view-point this mission has proved the most successful B-29 effort to date. With each succeeding mission the wrinkles in every department are being ironed out - soon a regular schedule of three large scale (100 plus aircraft) raids per month will be routine. The future missions, however, will still carry on the "Guinea Pig" role now being played by the XX Bomber Command.

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DIAGRAM I

| | MISHIMA 40th | KOBATA 444th | KIUSHU 462nd | TENGSHAN 462nd | TOTAL |
|---|---|---|---|---|---|
| DISPATCHED NEAR AREA (APPROX. FIGURES) | 29 | 34 | 27 | 31 | 121 |
| * ARRIVED FORWARD AREA | 27 | 29 | 23 | 29 | 108 |
| DES. OF ATTACK | 28 | 27 | 21 | 28 | 104 |
| AIRBORNE | 24 | 28 | 23 | 27 | 96 |
| EARLY RETURN | 2 | 7 | 2 | 3 | 14 |
| CRASHING | 1 | 0 | 0 | 0 | 1 |
| DESTROYED E/ACTION | 0 | 0 | 0 | 1 | 1 |
| UNACCOUNTED FOR | 0 | 0 | 1 | 0 | 1 |

* APPX. BOMBING LAT TARGET

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DIAGRAM II

| No. A/C DURING | HSINCHING 40th | KWANGMU 444th | KIUCHIAI 462nd | HSINCHU 468th | TOTAL |
|---|---|---|---|---|---|
| ANSHAN (PT) | 19 | 0 | 14 | 25 | 58 |
| CH ENANGTAO | 0 | 0 | 0 | 0 | 0 |
| TAKU (TT) | 0 | 17 | 0 | 0 | 17 |
| CHANGCHUN (LRT) | 2 | 3 | 0 | 2 | 7 |
| TARGETS OF OPPORTUNITY | 2 | 1 | 0 | 0 | 3 |

PT - Primary Target
ST - Secondary
TT - Tertiary
LRT - Last Resort

DIAGRAM III

| | HSINCHING 40th | KWANGMU 444th | KIUCHIAI 462nd | HSINCHU 468th |
|---|---|---|---|---|
| TIME OF TAKE-OFF 1ST A/C | 2225Z | 0317Z | 2215Z | 2221Z |
| TIME OF LANDING LAST A/C | 2301Z | 0410Z | 2304Z | 2310Z |
| TIME OVER TARGET 1ST A/C | 0410Z | 0658Z | 0415Z | 0403Z |
| TIME OF LANDING 1ST A/C (PT) | 0933Z | 1135Z | 1000Z | 0934Z |
| TIME OF LANDING LAST A/C (PT) | 1055Z | 1338Z | 1055Z | 1057Z |

DISTANCE TO PT - 2705 NAUTICAL MILES - AVERAGE PLANNED FLIGHT TIME 11 1/2 HOURS

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# MILITARY INTELLIGENCE DIVISION
## WAR DEPARTMENT GENERAL STAFF
### MILITARY ATTACHÉ REPORT

Country Reported On

Subject (Brief Descriptive Title) INFORMATIONAL INTELLIGENCE SUMMARY NO. 44-26 I.G. No.

Source and Degree of Reliability:

K-71311

Summarization of Report
When Required

In Comments on Current Events Enter Item Headings Here

Jap Fighters vs. B-29's in China

Jap Opinion of AAF Bombing Tactics

Jap Window Tactics at Saipan

B-17 Line-Abreast Bombing Formation in the Mediterranean Area

Effect of Formation Upon Flak Risk

FW 190 Deflection Gun

Battle Regulations for Japanese Hikodan

OSCARS Evade by Vertical Power Dive

Japanese Air-To-Air Bombing Tactics Against AAF Heavies

Jap Land Mines Used Against Low-Flying Planes in Marianas

Warhead of the Flying Bombs

Japanese Night-Bombing Tactics Against Shipping

Notes on Enemy Aircraft, Future Distribution of Technical Air Information on the Japanese Air Force, Arado 240, He 129 - Additional Armor Plate, Me 109G - Modified Armor Protection FW-190 - Special Power-Boosting Installation, and Ju 88 - Increased Armor.

G-2 Distribution: 4, 5, 6,
Copy No. 1, R/S; 2, L/C; 3, Section File

From M. A. AC/AS, Intel Report No. Date 20 August 1944
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# MILITARY INTELLIGENCE DIVISION
## WAR DEPARTMENT GENERAL STAFF
### MILITARY ATTACHÉ REPORT

Country Reported On

Subject (Brief Descriptive Title) INTERVIEW WITH CAPT. JOHN H. PETERSON I.G. No.

Source and Degree of Reliability:

K-69479

Summarization of Report
When Required

(In Comments on Current Events Enter Item Headings Here)

Air Service Command interview with assistant A-4 of the 20th Bomber Command. Report includes supply and service difficulties, preparations for the first B-29 attack on Japan, effect of Indian weather on B-29's, low morale of one service group, importance of the statistical officer, and suggestions of benefit to future B-29 outfits. Japanese intelligence.

G-2 Distribution: 4, 5, 6,
Copy No. 1, R/S; 2, L/C; 3, Section File

From M. A. [illegible] A.P.O. Report No. Date 27 JULY 1944
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# MILITARY INTELLIGENCE DIVISION

## WAR DEPARTMENT GENERAL STAFF

### MILITARY ATTACHÉ REPORT

Country Reported On

Subject ORIENTATION PRESENTATION FOR GENERAL GILES I.G. No.

Brief Descriptive Title

Source and Degree of Reliability:

K - 90095

Summarization of Report

When Required

In Comments on Current Events Enter Item Headings Here

CONTAINS:

STATION LIST AND STRENGHT OF THE 20th BOMBER COMMAND

SHORTAGE OF AIRPLANE MECHANICS.

EXCESS COMBAT CREWS

BASE PERSONNEL PROBLEMS

REST CAMPS

TECHNICAL DEVELOPEMENT OF B - 29

G-2 Distribution: 4, 5, 6,

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# MILITARY INTELLIGENCE DIVISION W. D. G. S.

JICA/CBI/SEA REPORT
MERCHANT VESSEL REPORT: JAPAN
(Country reported on)

Subject: B-29 ATTACK ON YAWATA, JAPAN — UNKNOWN
(Brief descriptive title)

From: JICA/CBI BR., Kunming, China — Report No. 6028 — Date 6 July 1944

Source and degree of reliability:

Data obtained by Lieut. F. L. Plake, USNR, from interviews with officers of the XXth Bomber Command.

SUMMARY.--Here enter careful summary of report, containing substance succinctly stated; include important facts, names, places, dates, etc.

1. Forwarded herewith is a report prepared by Lt. F. L. Plake, USNR, of Comnavu-14 on the B-29 attack on Yawata, Japan on 15 June 1944.

2. Comnavu-14 has forwarded a copy of this report direct to the Chief of Naval Operations (Op-16-V-1) with a request that a carbon copy be furnished the Office of the Commander-in-Chief, United States Navy. The 14th Air Force is cognizant of this report.

3. Attention isdrawn to the apparent complete surprise with which the mission caught the enemy, indicating a weakness in air raid warning net, radar, defensive weapons and aircraft.

CARL S. GRAYBEAL
Colonel, G.S.C.
Chief, JICA/CBI/SEA

SHONDEL M. HUNT, JR.
Lieut. Comdr., U.S.N.R.
Naval Air Officer,
JICA/CBI/SEA
Co-in-C, JICA/CBI Branch

SN-6028

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Distribution by originator: JICA, APO 885 (2), 432, 465, 879, files.

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REPORT OF B-29 ATTACK AGAINST YAWATA, JAPAN

15 JUNE 1944

Lieutenant F. L. Plake, USAF
Air Combat Information
Combat Unit, 14th Air Force

GENERAL On 15 June 1944, forty-seven B-29's of the 58th Bombardment Wing of the XXth Bomber Command hit the Imperial Iron and Steel Works at YAWATA (33-52N -- 130-50'E) at the northern end of KYUSHU Island, Japan. Two planes bombed the secondary target, the harbour at LAOYAO, (34-46'N -- 119-27'E) China. Home base for the operation was set up at SHUSING airfield near CHENGTU (30-40'N -- 104-05'E), China.

As an operational flight over a long distance with a new plane and the latest in modern equipment, the mission must be termed as highly successful, especially from an engineering standpoint. This, even though bomb hits in the target area produced no better than "fair" results.

(A) No attempt is being made to evaluate the target hit in comparison with other available targets in Japan. The target was laid on exclusively by Washington, and it is presumed that Washington had a good reason to (1) hit the mainland of Japan, and (2) to select the Iron Works over other targets in spite of the fact that damage thereto will not be felt in the front line for many months. (Presuming that there was damage of sufficient scope).

Certainly the use of this expended fuel could have better served the general war effort in China in those areas where the enemy threatens to cut off nearly half of present China, had it been committed to the use of fighter-bombers and B-25's against land targets in the Yellow River-Changsha area, and to the B-24's in shipping sweeps in the SHANGHAI-FORMOSA-HAINAN AREA.

The operation was conducted over a distance of 3208 statute miles, round trip, the longest yet attempted. It was the second operation of the 58th, the first being against targets (railroad marshalling yards) at BANGKOK 5 June, which was flown from the India bases below:

Seventy-five B-29's were despatched from bases in India for this, (the second) mission. Home bases of the units together with the number of planes brought forward for this mission are:

| | | |
|---|---|---|
| 40th | CHAKULIA | 18 |
| 444th | CHARRA | 18 |
| 462nd | PIARDOBA | 20 |
| 468th | KHARAGPUR | 19 |

These planes left their India bases, arriving at CHENGTU on D-2 days. In route they were loaded with bombs in the rear bomb bays, and fuels topping off at their CHENGTU fields (four were used), where the bombs were fused.

NOTICE No one of the XX was aware of this mission until 7 June when they were handed an order "On 15 June, Japan will be bombed, the target will be _____", or words to that effect.

At that time, reports of the BANGKOK mission were not in the hands of Bomber Command Headquarters. Washington had no knowledge of how many planes were operational, having been informed only of planes lost during the mission. This did not set too well with personnel of either the XX or the 58th.

All intelligence and target material was prepared by Washington.

No Photo Reconnaissance was flown prior to or (at least until 18 June) following the bombing.

FROM: JICA/CBI Br., Kunming, China. Report No. 6028. 6 July 1944

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BOMB LOADING The bomb loads carried were eight 500-pound G.P. (M-17-43) fused 1/10 nose and .025 tail. On the BANGKOK mission planes carried from 10 to 16 500-lb. G.P. or Incendiary bombs with the average load per plane being about 6,000 pounds.

FUEL Each plane was loaded with from 7,400 to 7,500 gallons of burnable gasoline. They carried 7,800 gallons. Due to the construction of the wing tank units which does not allow each unit to be completely emptied, there are approximately 300 gallons that cannot be burned. There was a safety margin of 1,400 gallons figured (5-hours cruising). Planes completing the mission had from 1,200 to 1,600 gallons remaining. Following the BANGKOK mission the difference in fuel consumption between the most economical and the most hoggish plane was about 1,540 gallons. It is felt that pilot-crew inexperience was abcut 85-percent responsible for this wide variation.

TAKE-OFF The take-offs from the four fields near CHENGTU were scheduled for 1630 on D-day. The times of first and last take offis were:

| | | | |
|---|---|---|---|
| 40th | 1616 | 17 4 | |
| 444th | 1624 | 1658 | |
| 462nd | 1625 | 1659 | |
| 468th | 1624 | 1828 | (*) One plane crashed on takeoff delaying takeoffs of last three planes considerably. |

Planes weighed from 129,900 to 132,000 pounds at takeoff. Due to recent rains plus the fact that only portions ofthe runways had oil covering (all availatle tung oil in the vicinity had been used, but, nout enough), takeoff runs ranged from 2200 to 2400 metres. This was at 2,600 RPM's pulling 47.5 inches of mercury. Takeoff comes with 115 m.p.h. speed. B-29 fields have a takeoff runway of 2,600 metres.

Two planes crashed on the takeoff: One of the 468th crashed when pilot was unable to get sufficient speed and attempted to stop. All escaped with most severe injury of mud in ears when some personnel were thrown in rice paddy. The second photo plane ofthe 44th crash, burned with none escaping.

| | | | |
|---|---|---|---|
| Aircraft airborne were: | 40th | 16 | |
| | 444th | 15 | |
| | 462nd | 18 | |
| | 468th | 18 | = TOTAL = 67 |
| Early returns were: | 40th | 4 | |
| | 444th | 0 | |
| | 462nd | 1 | |
| | 468th | 1 | = TOTAL = 6 |

The worst single feature of the B-29 is its takeoff characteristics. At best it is a sluggish plane that must be lifted on every takeoff by the crew and the spectators. One plane which crashed 80-air miles from takeoff was considered by all to not really have become airborne. This is due partly to the tremendous weight that must be lifted plus the construction of the cowl flaps which, when opened for takeoff, open outward in such a manner as to cause greater wind resistance and drag. Therefore, takeoffs are with vents closed.

This means that the engine becomes very hot which does not interfere Unless the rate of climb is exceedingly slow andthe temperature increases beyond operating efficiency. Pilots and crews are looking forward hungrily at the new Pratt 3,000 h.p. job which is supposedly going into the 29's of the 73rd wing as standard equipment. The Wright 2,000 engine is certainly not cared for by the men who fly them. They claim they are undependable (one sputter at 2,000 yards and you're down for keeps), and have a tendency to throw oil. Only three engines (Nos. 1, 2 and 4) on three aircraft came back feathered. Several others were noticed to be throwing a lot of oil. The day following the mission all planes could have been flown. However, before the next mission, it is expected that 50 percent of the engines [illegible] will be changed and overhauled at leisure at the rear bases. Sufficient spare engines are available for this [illegible] effort.



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COURSE Following the takeoff, planes went immediately on a direct course to the target. An altitude of 7,000 feet had to be reached within approximately 300 miles of takeoff. Within 500 miles, the planes had to climb to approximately 8,000 feet. Going over water, most dropped to less than a thousand feet.

In the disc etion ofthe pilots, they left China coast at approximately 33-30'N - 120-30'E, and passed to the north of SAISHU Island. When at approximately 33-40'N - 129-00'E, the planes changed course, taking them to the I.P., (KINO Island, at 34-13'N - 130-05'E. From here they made their run to the target at 122° T.

Planes proceeded to the target singly with no joining-up or formations attempted. This was due to the difficulty of holding formation for such a long period at night, and lack of fuel necessary for jockeying into position.

BOMBING Pilots were allowed to use their discretion in bombing fro thousand foot levels, between 8,000 and 10,000, andbetween 14,000 and 18,000 feet.

It was not specified whether bombing should be done visually or by radar. If by bombsight, spacing should be 120 feet; if by radar, 180 feet.

WEATHER The weather forecast predicted cloud covering of rrom 6/10 to 8/10 over the target. It was 5/10.

RADIO SILENCE IFF would be turned off when aircraft were 125 miles from CHENGTU and not turned on again until with 125 miles of CHENGTU on the way back. Radio silence was to be maintained except (1) First plane over the target was to send back a coded message which would be forwarded to Washington to allow the President to announce that planes were bombing Japan, and (2) in case a plane was in emergency, when position would be sent in code.

TARGET BOMBED AND RESULTS The first plane to reach the target bombed at 2256, just three minutes earlier than was calculated by the Wing Navigator.

Fifty-two planes were over the primary target of YAWATA. Of this number, forty-seven dropped their bombs. One was seen in a tight spiral over target and was believed to have crashed there, due to AA fire. Four had to jettison their bombs; due twice to faulty bomb bay doors, once to navigational error andonce to faulty release equipment.

Of these forty-seven (47) aircraft dropping bombs at the target, thirty-four (34) dropped by radar. This was rather puzzling since most of crews indicated their belief to favor dropping by bombsight and since only eight claimed not to have had a good sight of the target; it is believed that this latter figure was exaggerated.

Two planes bombed the secondary target, the harbour of [illegible]; one visually, and one by radar.

Reports of bombing were "excellent" to "poor" with a concensus being "fair." Some of the more experienced operational officers on the trip believed that while there were many hits in the area, that they caused slight damage. Some of the runs described by crews as having been "good" were shown by radar photos to be as much as [illegible] miles off the bomb course.

Damage was not noted (no Photo Reconnaisance having been flown as of 18 June). Several pilots reported "Two cherry colored fires", while others say these were dumpy fires nearly three (3) miles from the target area.

At no time during the operation were enemy aircraft encountered. Two pilots believed they saw tracers passing them at the target. This was pretty generally poo-pooed by the others. It must be remembered that planes passed within fifty miles of the KUMKO area where there are supposedly at least 400 enemy aircraft.

The anti-aircraft guns were slow in opening up. When they did they were light, very inaccurate and spasmodic. One plane was seen to accept AA bursts and to spiral down over the target. Most of the bursts came up as though the Japs were attempting to lay down a barrage. In general, these barrages were far ahead of the



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plane although some were left. The AA altitude was often off but this was probably due to the planes coming in singly instead of in formation, and at such varying altitudes.

BLACKOUTS - Lack of All crews reported that there was no blackout or dim out until the target was reached. First planes over say that there were many lights visible in YAWATA but these were extinguished by the time the fifth plane was over the target and the blackout was excellent. (Even when the target area was blacked out, lighthouses and other navigational aids were on. Ships carried lights and were easily visible from several miles. What is believed to be a Japanese lightship was sighted at approximately 34°N - 130°E.)

AIR RAID WARNING NET Apparently there was no advance warning of the raid. This was in spite of the fact that the aircraft flew 250 miles over enemy occupied China. In addition, planes flew within fifty miles of the Jap held HANKOW area, where, it is estimated, 400 enemy aircraft are based.

PLANE PERFORMANCE Returning crews complimented the performance of their respective planes highly. The worst single difficulty in flight is with the electric fuel transfer apparatus which fails all too often. Unlike the B-17's, there is no equipment for the manual transfer system. This caused three early returns this time and two losses on the BANGKOK mission.

LANDINGS Landings of first and last planes of each group at the CHENGTU fields were:

| | | |
|---|---|---|
| 40th | 0558 | 0757 |
| 444th | 0631 | 0740 |
| 462nd | 0706 | 0835 |
| 468th | 0612 | 0835 |

Immediately upon landing, planes were refuel with 3200 gallons each, preparatory to moving to their respective bases in India. Including transports, there were eighty-three (83) B-29's in CHENGTU, 17 June 1944, all in flying condition.

CONCLUSIONS While the operation of 15 June must be considered a success, there are several points on the record of the XXth AAF which must be commented upon. Before going further, the organization is explained in the following diagram:

20th AAF

- XXth B.C. — 58th B.W.
  - 40th
  - 444th
  - 462 nd
  - 468th
- XXIIIrd B.C. (Being formed) — 73rd B.W. (Ready to go 15 July)
- XXIInd B.C. (Not being formed)

Commanding General of the 20th AAF is General H.H. Arnold; of the XXth Bomber Command is Brigadier General K. G. Wolfe, and, of the 58th is Brigadier General L. G. Sanderson.

Under the present setup the unhappy situation exists where there is a Wing Headquarters and a Group (Command) Headquarters with no job for the latter except to usurp the duties of the Wings. This was competently accomplished for this operation. When another Wing is added, this situation will be removed.



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After refueling the planes for the trip back to India, the crew was told enough gasoline remained to gas the jeeps that bring wood for the cook stoves. The pipe line or a port will really be fully appreciated by this outfit.

Incidentally, this outfit is watching the 73rd Wing which, it is said is due for a Pacific billet by 1 September. They think it will be SAIPAN or GUAM. General Wolfe said they could have carried five (5) tons of bombs (instead of two) had this operation been from the MARIANAS, thereby eliminating any climb for altitude until the expendable fuel had sufficiently lightened the planes.

No one could understand how a Congressman (STARR (?)) got the word that TOKYO had been bombed. Or, how anyone got off on the tangent that the _____ tunnels had been hit. Not, hit at, since the crews were not even aware of any tunnels and no word of their presence was carried in the briefing pppp.

No briefing had been done on currents, winds, survival at sea, etc., before the writer's briefing the morning before theft mission. The attitude of all was that there was no necessity for briefing on that type of information before the crew was down, that word could be gotten to them after they went down.

Colonel Vinson, A-2 received the outline enthusiastically and that morning from [redacted] an hour was spent briefing all A-2's, S-2's and Navigation Officers in survival.

Although the rescue facilities set up by the Navy were not called upon, this writer was assured many times of the appreciation of the crews and headquarters personnel in the preparation.

The security of this mission was exceptional. No one knew of the mission until 7 June. The Radar Officer was not given full details until 11 June, attending briefings simultaneously with other key officers. Enlisted personnel in India were led to believe that planes were taking off on a routine training mission when the planes left for China.

The night of the mission, following the takeoff, a pool was made at $1 per, listing twenty targets about evenly divided between the China mainland, the Philippines, Formosa and Japan. Even money bets could be obtained that the target was either Japan or the Philippines.

A telephone call from one field to another reporting aircraft status on D-2 day practically turned Gen. Saunder's hair grey. It could have been very serious but had apparently no effect.

| SUMMARY OF OPERATIONS | 40th | 444th | 462nd | 468th | TOTAL |
|---|---|---|---|---|---|
| Aircraft airborne | 16 | 25 | 18 | 28 | 87 |
| Early returns | 4 | 0 | 1 | 1 | 6 |
| Aircraft over target | 11 | 12 | 15 | 14 | 52 |
| Aircraft bombing primary target | 11 | 10 | 13 | 13 | 47 |
| Aircraft bombing secondary target | 0 | 0 | 2 | 0 | 2 |
| Aircraft bombing target of opportunity | 2 | 1 | 1 | 1 | 5 |
| Aircraft jettisoning | 0 | 2 | 2 | 0 | 4 |
| Aircraft crashing | 0 | 0 | 0 | 1 | 1 |
| Aircraft missing | 0 | 1 | 0 | 0 | 1 |

NOTE: Photo plane (#220) of 444th crash on takeoff. One aircraft of 468th crashed on takeoff. Thirty-five (35) of the forty-nine (49) bombed by radar.

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# MILITARY INTELLIGENCE DIVISION

## WAR DEPARTMENT GENERAL STAFF

### MILITARY ATTACHÉ REPORT .....

Country Reported On

**Subject** SUMMARY OF MILITARY OPERATIONS REPORTED IN THE ~~CHINA THEATER DURING THE PERIOD 18-24 JUNE 1944~~ W/1 MAP **I.G. No.** .....

Brief Descriptive Title

**Source and Degree of Reliability:**

K-70550

**Summarization of Report**
When Required

In Comments on Current Events Enter Item Heading Here

Source: M.A. Includes enemy ground and air operations, Allied air operations.

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